YPT

A radio listener in Los Angeles writes: "The commentator for KHJ tells us that Longines watches are good watches. I can verify that statement for I am carrying a Longines watch my father gave me when I was 15 years of age and it still keeps perfect time. I am 78 years young now; that was 63 years ago." ¶ Since the first Longines was made in 1866, millions of people all over the globe have also verified the statement that Longines watches are good watches. Ten world's fair grand prizes, 28 gold medals are further verification of the forthright statement made by our old friend from California.

*From documents in our files

Longines-Wittnauer Watch Co., Inc., New York, Montreal, Geneva: also makers of the Wittnauer Watch, a companion product of unusual merit.

ON THE AIR

The Symphonette, M. Piastro, conductor, on the air coast-to-coast in frequent Longines concerts of "The World's Most Honored Music." See your newspaper for station and time.

Sky and TELESCOPE

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The Editors Note . . .

OUR FIRST fascination with letters from abroad is the stamps they bear; then we have the pleasure of learning what amateurs and professionals in other climes are doing. Recently, three letters came through from A. T. G. Brito, Y.M.C.A., Colombo, Ceylon, one requesting information, the others giving it by word and picture.

Mr. Brito wants to know why the statement has been made that from the planet Venus the earth would appear about six times as bright as Venus does in our sky. He points out that the earth is farther from the sun, that it is hardly larger than Venus, and that Venus has a higher albedo. The explanation is found, considering "greatest brilliance" conditions only, in the crescent phase of Venus as we see it when it is brightest and the full phase of the earth as seen from Venus when the two planets are at their nearest.

In his second letter Mr. Brito reports at length on the partial eclipse of the moon on the night of August 15-16, 1943, which he observed near "the bewitching hour of midnight with a new day being ushered in, while you were just after your mid-day meal." That evening, as the moon rose behind thin clouds, he had no trouble seeing both Venus and Mercury in the western sky; also in the sky were Centaurus and the Southern Cross. The moon entered the umbra behind thick clouds, so many spectators called it a night; however, the clouds lifted shortly thereafter. Mr. Brito describes the successive obscuration of various lunar features, accompanied by the appearance of stars near the moon. He had difficulty reading a clock outdoors when the eclipse reached its maximum of about 7/8 of the moon's diameter; the time was 12:58 a.m., Ceylon Standard Time, 5½ hours faster than Greenwich.

Clouds brought on by the southwest monsoon, seasonal in August, marred the conclusion of the eclipse at 2:28 that morning. In his third letter, Mr. Brito transmitted a water-color sketch of the moon in eclipse, as seen above beautiful tropical foliage by B. Nallin Perera of Dehiwala, Ceylon; we regret that space does not permit reproduction of the sketch.

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APRIL, 1944

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BACK COVER: An edge-on spiral in Andromeda, NGC 891, photographed with the 60-inch Mount Wilson reflector; exposure, 7 hours, 15 minutes, on two nights, November 23, 24, 1916.

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STARS OF SPRING

By Marian Lockwood

With the coming of warmer nights, stargazing takes on new impetus. Here, and in the Hayden Planetarium this month, many of the spring-time constellations and objects of interest in the spring sky are discussed.

ALTHOUGH the stars of the winter season are without doubt the most brilliant of all, and the most spectacular in arrangement, the stars of spring are always eagerly welcomed back to the sky by stargazers everywhere. After the long winter months, with their penetrating cold and high percentage of stormy nights, the amateur astronomer steps out under the balmy skies of spring with a deep sigh of relief. Out come the homemade reflectors, the dearly cherished star charts and lists of celestial objects. And don't let's forget to mention also the great number of opera glasses and binoculars that are being polished up these nights, and turned with rapturous attention to the easier double stars and clusters. For the Spring Star Hunt is on.

Almost everyone knows the Big Dipper: it is undoubtedly the most popular and familiar group of stars in the northern sky. If you are not sure that you can recognize it at sight, consult the star map in this issue of *Sky and Telescope* on page 22. At about 10 p.m. E.W.T., on the 1st of April, the two Pointers at the end of the bowl of the Big Dipper will be almost above the North Star and pointing directly to it. The curved handle of the dipper will be trailing off toward the east. The Big Dipper is usually listed as a spring star group because it is in such an advantageous position for observation in the early evening at this time of year. It is, of course, not listed as a constellation by itself, but is part of the very ancient constellation Ursa Major, the Greater Bear.

Here it should be remembered that any given star or constellation will come back to the same position in the sky four minutes earlier tomorrow night than the time it reached that position tonight; any given star rises four minutes earlier on succeeding nights.

In most constellations the brightest star is given the first letter of the Greek alphabet, the second brightest is given the second letter, and so on. In Ursa Major, however, the stars in the Big Dipper are named according to position in the dipper, the one at the very outside and upper edge of the bowl being called Alpha; the one below it in the bowl, Beta; and so on, around to the end of the dipper's handle, which is Eta. With these Greek letters, the genitive of the constellation name is used, as Alpha Ursae Majoris.

The stars, many of them, also have proper names, mostly from the Arabic. This is natural since the Arabs were fine astronomers, and, living beneath the open sky in their tents, had wonderful opportunities to observe the heavens. Alpha in the Big Dipper is otherwise known as Dubhe (which means "the bear") and Megrez, the faintest star in the dipper, where the handle joins the bowl, means "the root of the tail." The handle of the dipper, of course, is the same as the tail of the bear.

All stars in the Big Dipper are 2nd magnitude, with the exception of Megrez, which is 3rd. Dubhe is a standard 2nd-magnitude star, 2.0, and as such has been used as a comparison star to determine the apparent magnitude of others.

Just above Mizar, the second star in the handle, is a star known as Alcor. Although it is faint, magnitude 4.8, it should be readily seen by anyone with normal eyesight. The Arabs called

A Yerkes photograph of the familiar Big Dipper shows clearly its seven bright stars, and many others besides.

Mizar and Alcor "the horse and the rider," and regarded the fainter star as a test for good eyesight. According to Agnes Clerke, the astronomical historian, the proverb *"Vidit Alcor, at non lunam plenam* came to be a proverbial description of one keenly alive to trifles, *but dull of apprehension for broad facts."*

The amateur astronomer will find it convenient to remember that the two pointer stars, Dubhe and Merak, which point out the North Star, are just about 5½ degrees apart. This stretch between the two stars may be used as a measuring rod to estimate the distance between other stars.

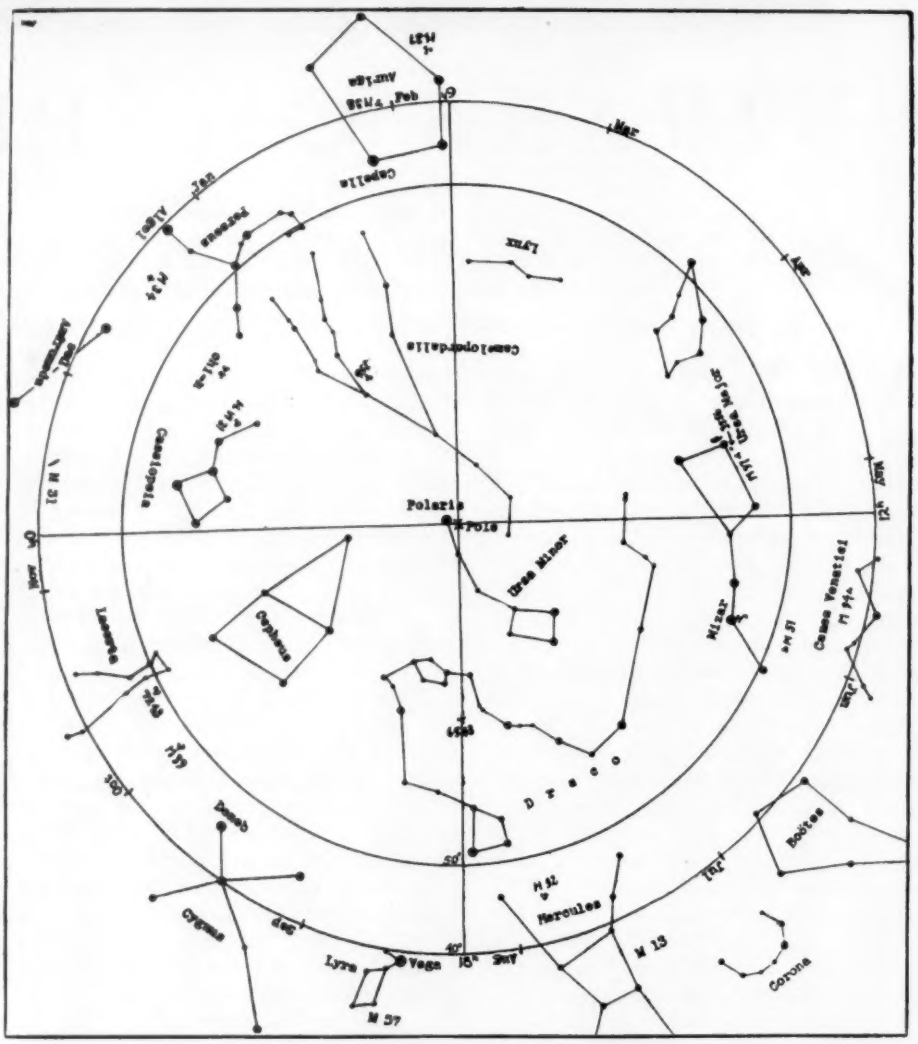
From latitude 41° north, and north of this, the Big Dipper is a circumpolar group, never setting at any time of day or night. Of course, at latitude 41° north the pole star is about 41 degrees above the northern horizon, since the altitude of the pole is equal to the latitude of the observer. Since Polaris is very close to the center of the northern hemisphere of the sky, no star that is within about 40 degrees of this star can possibly disappear below the horizon. Therefore the Big Dipper is visible every night of the year and every hour of the night when the sky is clear, from latitude 41° north and farther north.

We see the Big Dipper in changing relation to the North Star at the same hour of the night at different seasons. In the autumn, broadly speaking, the dipper is below the pole; in the winter, standing more or less on the end of its handle in the eastern sky; in the spring, above Polaris; and in the summer, to the west of the pole star, supported on the end of the bowl, handle upward.

Ursa Minor, the Lesser Bear, in which we find the Little Dipper, is distinguished mainly because it contains the most important single star in the night sky, Polaris, the pole star, which is just one degree from the true pole. Polaris can be found very easily by extending the line between Merak and Dubhe (the Pointers) about five times the distance between them. Polaris is a 2nd-magnitude star, 2.1, just a trifle fainter than Dubhe. Like Dubhe, it has been very extensively used as a comparison star. It is about 400 light-years from the earth. Since Polaris is so close to the celestial pole, the other stars in the northern sky seem to whirl around it like the parts of a great wheel.

The Little Dipper is harder to locate than the Big Dipper because most of its stars are much fainter. It may help you in finding it to know that the handle of the Little Dipper bends the other way from that of the Big Dipper.

Historically, Ursa Minor is of much interest. About 600 B. C. the Greeks accepted it officially as a constellation, persuaded by Thales that its use as a navigation group had many advantages over the use of Ursa Major. Up to this



The circumpolar stars of northern latitudes. With the month held at top, and the observer facing north, the chart will be oriented correctly for 10 o'clock war time, about the first of each month.

time the Big Dipper had been very generally used in this part of the world as a guide to mariners. It was not until Thales visited Phoenicia and saw the use made there of the Little Dipper that the group was accepted by the Greeks as a navigation aid.

Perhaps the outstanding constellation of the spring sky is Leo, the Lion. Here again let us go back to the Big Dipper, using the pointer stars. Instead of drawing the line through Merak to Dubhe and beyond, as we did in finding the pole star, we draw the line from Dubhe to Merak and on, about as far as we did in finding the pole star but in the other direction. This will bring us into the middle of Leo. To the west of this line will be seen a group of stars resembling a sickle or an inverted question mark, one of the most widely known asterisms in the spring sky. The base of the handle of this Sickle is the 1st-magnitude star, Regulus. Regulus is the faintest of the 20 stars of the 1st magnitude, but is nevertheless of great interest astronomically and historically. In ancient times it was known by the Persians as one of the four royal stars, the others being Aldebaran, Antares, and Fomalhaut.

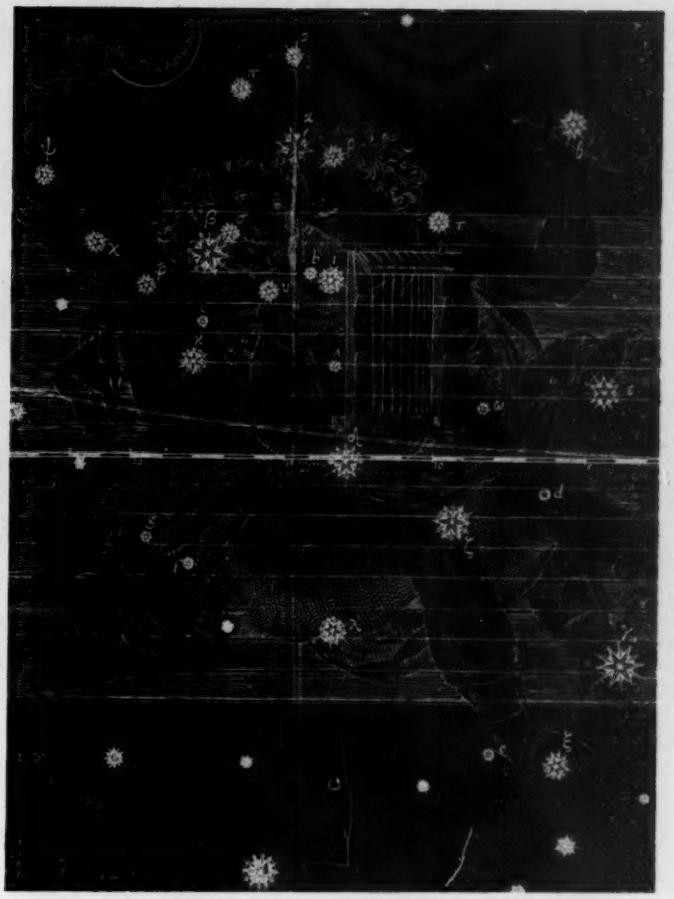
To the east of the line you have drawn through Dubhe and Merak to find the Lion, you will discover a right-angle triangle of 2nd-magnitude stars. The most easterly star is known as Denebola, probably once *Deneb Leo,* the tail of the Lion.

South of Leo and stretching over 90 degrees across the sky is the faint constellation Hydra, the Water Monster. If you will draw a line from Gamma Leonis, the brightest star in the blade of the Sickle, through Regulus, and continue that line somewhat more than twice its length, you will discover Alphard, the lucida of Hydra. This star was known as "the lonely one" because of its isolated position in a part of the sky where only faint stars are seen.

Certainly no account of the spring evening sky would be complete without mention of two other constellations, Gemini and Auriga. Refer again to the star map and you will see that Gemini is a constellation containing two bright stars, Castor and Pollux, the Heavenly Twins. Auriga is a five-sided group with one very bright star, Capella.

On the 1st of April about 10 p.m. E.W.T., both of these constellations will be in the west, Auriga very much to the north of west. Of the twin stars, Castor is on the side of Gemini toward Auriga.

Castor and Pollux were favorite gods of the Romans, and when the Roman soldiers went into battle they believed that the two gods led them on to victory. One of their favorite oaths was "by the Gemini," which, so it is said, has been corrupted until in our day we say simply, "by Jiminy."



Gemini, the Twins, as pictured in Bayer's "Uranometria." One of the interesting riddles about this constellation concerns the naming of its Alpha and Beta stars. Was Castor once the brighter of the two?

In Gemini, Castor is Alpha and Pollux, Beta, although Castor has an apparent magnitude of only 1.6 as compared with the 1.2 of Pollux, almost a half-magnitude difference. It is believed that Castor may have diminished in brightness since the time when it received its lettering.

Orion, the most brilliant of winter constellations, sets early on spring evenings. Here the fixed camera of D. C. Wysor catches its bright stars trailing toward the horizon.

Capella, in Auriga, is a very brilliant yellow star, fifth in apparent brightness among them all. You can be sure that you have located Capella if you can find three fainter stars forming a triangle very close to it. Capella is the Little She-Goat, and the three faint stars nearby are known as the Kids.

Auriga is not circumpolar in this latitude, but is so far north that it is in the visible sky longer than most non-circumpolar constellations, and Capella is circumpolar north of Ottawa and Portland, Ore.

In the spring, Cassiopeia, a W-shaped group of stars, is close to the northern horizon, below the pole star. Cassiopeia can be found by extending the line from the Pointers to Polaris as far beyond Polaris again. Cassiopeia is in the Milky Way, which band of starlight extends almost all the way around the horizon early on spring evenings. Nearly overhead is Coma Berenices, a faint cluster of stars above the tail of Leo and which contains the pole of the galaxy.

And this is merely a beginning, for the stars of spring, as of each season as it comes, are legion. The true star-gazer, and *that* he may be whether he knows his star names or not, thinks in the spring of that poem of Thomas Moore's, which says:

By cloudless starlight on he treads,
And thinks no lamp so cheering
As that light which Heaven sheds.

NEWS NOTES

By Dorrit Hoffleit

PRAY FOR AN EXPLOSION!

George Gamow, of George Washington University, known to many of our readers for his Mr. Tompkins and as author of *The Birth and Death of the Sun,* continues to theorize and to investigate the consequences of theories on stellar evolution. In a note on "Contractive Evolution of Massive Stars" in the *Astrophysical Journal,* he discusses such types as P-Cygni and Wolf-Rayet (varieties of high-luminosity blue stars), nuclei of planetary nebulae, and supernovae.

The nuclei of planetaries (not related to planets) are stars which are several magnitudes fainter than the Wolf-Rayet stars, and Gamow assumes them to represent a consequence of Wolf-Rayet evolution. The temperatures at the centers of these two classes of stars are computed to be of the order of 100,000,000 and 1,000,000,000 degrees centigrade, the planetary nuclei being the hotter. At such temperatures, large quantities of neutrinos are produced. "The rapid cooling of the interior through the escape of high-energy neutrinos must inevitably cause a rapid collapse of the stellar body," says Dr. Gamow. This would be observed as a violent supernova explosion, which he hopes may be seen in one of the known planetaries during our lifetime.

SIR CHRISTOPHER WREN, THE ASTRONOMER

The architect of St. Paul's was an astronomer. Howard L. Kelly, in the *Journal* of the British Astronomical Association, commemorates Christopher Wren, a mathematical genius in early life, professor of astronomy at Gresham College at the age of 25, Savilian professor of astronomy at Oxford at 28 (in 1660) and one of the foundation members of the Royal Society. Wren was much interested in problems arising from Kepler's laws. The story goes that he offered a prize to either Hooke or Halley should one be able to demonstrate that gravity would produce elliptical orbits. Halley proposed this problem to Newton, the problem that became the "germ" of the *Principia.* In that work, Newton pays tribute in naming Wren, John Wallis, and Huygens "easily the foremost geometricians of the age."

In 1661, Wren was appointed assistant to the surveyor-general to the Crown. In that capacity, and later as Surveyor of the King's Works, his architectural achievements evolved. While he ceased to be a "professional" astronomer, he still devoted much time to research and contributed learned papers to the Royal Society. As Mr. Kelly aptly summarizes: "It might not be amiss therefore to conclude that Wren the professional astronomer completed his astronomical career as a brilliant amateur."

Greenwich Observatory was designed by Wren, a fitting juncture of both his professions. Incidentally, that observatory hopes to move to a new address after the war, according to a news release from London. Greenwich, like many old observatories, has suffered from the growth of cities. "When the sun gets low, sunlight is so weakened by smoky atmosphere that it is impossible to get registrations on the sunshine recorder."

ASTRONOMY SCHOLARSHIP

Dr. Michael S. Kovalenko, retired member of the Sproul Observatory, has established at Swarthmore College the Jessie Kovalenko scholarship in astronomy, in memory of his wife. Recipients are to be Swarthmore students, preferably women, whose main field of interest is astronomy.

LONG-RANGE WEATHER FORECASTING

Recent months have seen a great increase in optimism concerning weather predictions. Last September, five different methods of long-range forecasting were discussed in the *Bulletin* of the American Meteorological Society and all were found wanting. In January, Science Service commented on a report by Gen. H. H. Arnold, in command of the Army Air Forces. Because fighting men "simply had to have them," forecasts for periods of two, 10, and 30 days are now possible with sufficient accuracy for the Air Force to plan future operations. "By pooling all information in the United Nations meteorological brains," the release states, "together with some further knowledge captured from German sources, the job was done, and put on a world-wide scale at that."

IMMORTALITY

Infinitely small
With his second of time,
Gigantically brave
In his armor of truth,
Mystically tall
In his dream realized,
Man reaches afar
Into eternity's night
And gathers divinity
From the timeless stars.

GERTRUDE GOUVY

Dr. Charles G. Abbot, secretary of the Smithsonian Institution, is, however, the boldest yet in long-range forecasting. He has found such good correlations between weather and solar phenomena, and has seen some of his previous predictions so well verified, that he is not only forecasting the weather for one locality for the remainder of 1944, but he is actually predicting great droughts in the Northwest for the years 1975 and 2020. These will result, he predicts, in a serious lowering of the water level in the Great Lakes.

WORLD-WIDE INTEREST IN METEORS

Astronomical literature received within the past few months includes numerous articles on meteoritics. They show a world-wide enthusiasm for this subject, both among amateur and professional students. In particular. we have at hand articles from England, Canada, New Zealand, and Russia. The topics covered by these foreign publications include the reality of observed hyperbolic velocities; meteors on the moon; meteor trains and their bearings on studies of the earth's upper atmosphere; the relationship of certain meteor streams to comets; and colors of meteorites.

Hyperbolic velocities imply that before colliding with the earth, the meteors had come from beyond the solar system. We are sure, from various lines of reasoning, that extra-solar-system meteors must exist. But when anyone claims to have observed them, the errors of observation make his claims dubious. Meteors always come unexpectedly and last at best but a few seconds. If the heights are estimated too high, the velocities come out too fast. This topic is perennial and we find mention of it in several recent papers.

Meteors are also certain to hit the moon in large numbers daily. What has been reported by the relatively few observers who have tried to see the results of such meteors striking the moon is quite inconclusive; it is desirable to have observers with large telescopes systematically watch the dark side of the moon. Even though this were done, we should not expect too much.

No less than six showers of meteors (listed in Denning's catalogue of meteor radiants) resulted from the disintegration of the great Comet 1882II, according to S. V. Orlov, of the USSR. The Orionids and a stream radiating from Aquarius originated from the nucleus of Halley's comet, he finds. Another Russian scientist, E. L. Krinov, has made a spectrophotometric analysis of 40 stony meteorites; they are appreciably redder than the asteroids, but the significance of this result is not discussed.

News from Moscow

IN THE Moscow *News* of September 11th and 22nd, 1943, copies of which reached the United States recently, appear articles headlined, in the earlier issue: "Astronomers' Conference is Convened — 40 Scientific Workers Expected to Attend Moscow Meet," and "Prof. Pryanishnikov Gives 1,000 Lectures to Men in Frontlines"; and in the later issue: "Astronomers Have Conference in Moscow, Hear New Theory on Formation of Solar System — Soviet Scientists Consider Nuclear Reaction of Elements Comprising Sun Caused 'Ejection' of Planets."

So well are the activities of the Russian astronomers reported that there seems to be no need to elaborate on the following verbatim excerpts from these articles in the Moscow *News,* which is published in English:

An all-union conference of astronomers is being convened in Moscow on September 14 by the Academy of Sciences of the USSR.

The most ambitious of its kind since the outbreak of the war, the conference will be attended by leading Soviet scientists working in various fields of astronomy and members of the staffs of observatories and scientific research institutes in Central Asia, the Transcaucasus and Siberia. It is expected that some 40 scientific workers will participate in its labors.

According to Professor Alexander A. Mikhailov, Chairman of the Academy's Astronomical Council, the conference will study the latest work of Soviet scientists in astrometry, astrophysics, celestial mechanics and other fields of astronomy, as well as perspectives for the future. An item on the agenda will also be measures for restoring Nazi-wrecked observatories and building new ones.

"Of the 19 observatories in our country before the war," the professor told Moscow **News,** "nine were situated on territory temporarily occupied by the enemy."

Enemy Bombardment

Although the central observatory in Pulkovo, near Leningrad, was not occupied, it was wrecked by Nazi air and artillery bombardment. Fortunately most of the equipment (the less bulky) and most of the priceless library were removed to safety in good time by the staff, which is now carrying on in Tashkent, Abastumani and Alma-Ata. The equipment of a small observatory in Poltava, engaged chiefly in recording the movement of the earth's poles, was evacuated to Irkutsk in Siberia.

"Details of the fate of the rest of the observatories in German-occupied territory are lacking, but information on hand indicates that a big job awaits the Soviet Government and Soviet scientists in their restoration."

According to Professor Mikhailov, the conference will consider concrete measures for restoring the Pulkovo Observatory and for building a large new one for the Kazakhstan branch of the Academy and an astrophysical observatory in the Crimea or in Central Asia. An astrometrical observatory planned for construction in the southern part of Russia can only be begun, of course, after the war. The same holds true for other new and restoration projects.

Interrupted by War

"The question of setting up new stations for observing the movement of the earth's poles will also be discussed," the scientist went on. "International investigation of this phenomenon by a chain of stations established on the same latitude has been interrupted by the war.

"Although the war has upset our previous regular contact with scientists abroad, we trust that our American colleagues are carrying on. The Soviet international latitude station in Kitab, Uzbekistan, is functioning regularly.

"Soviet astronomers are now planning to obtain exhaustive data on the movement of the earth's poles on the basis of observations made by stations situated on various latitudes in this country."

New Invention

A new invention, not generally known as yet, will be the subject of a paper by Professor D. Maksutov. This scientist has designed a new type of reflector telescope with a correction lens, which, according to Professor Mikhailov, will effect a revolution in astronomical optics. Thanks to it, telescope lengths may now be reduced nearly eight times. Moreover, the quality of the images is even improved.

The reflectors proposed by Professor Maksutov are also said to be easier to produce than existing ones.

LENINGRAD (by wire)—Professor V. I. Pryanishnikov, noted Soviet astronomer, enjoys great popularity as a front-line lecturer. Since the beginning of the war, he has delivered about 1,000 talks to Red Army men and commanders on active service on such themes as "Science Aids the Scout," "How to Find Your Bearings Without Instruments" and "Science Aids the Sniper." Professor Pryanishnikov maintains regular contact with his audiences, members of which send him many letters.

The solar system could not have originated as the result of particles of the sun being pulled away by the attraction of a passing star, as Sir James Jeans held, declared Docent Nikolai Pariisky at the recent All-Union Conference of Astronomers in Moscow. The results of long years of research with which Pariisky acquainted the conference confirm Henry Russell's hypothesis that such a phenomenon could not have given the planets thus formed a sufficiently rapid rotary movement (angular momentum) about the sun.

The error made by the famous English astronomer is understandable, for in 1916, when he advanced his theory, it was considered that at the period when the solar system originated the sun was considerably larger than it is today. If such were the case, Jeans' theory would arouse no objections. But today we know that since the origin of the solar system the size of the sun has decreased only negligibly. True, it was four or five thousand times larger in the nebular state, but that was long before that.

Pariisky informed the conference of the new theory of the origin of the solar system that has been developed by Academician Vasili Fesenkov and his collaborators, according to which it came into being without the interference of an outside body such as a passing star. On the basis of atomic physics data, it is now considered as established that the nuclear reactions of the various elements comprising the sun are the source of solar energy. In the course of these reactions there occur critical periods in the life of the sun, when it suddenly contracts and decreases in volume, and it was during these periods, according to the suppositions of the Soviet astronomers, that "ejection" of the planets from the sun took place. The speaker pointed out that as far as can be judged at present the new theory is in keeping with all scientific data, and called upon the astronomers of the USSR to participate in its collective development and substantiation.

Another report that evoked much inter-

(*Continued on page 19*)

Caption on picture from the Moscow "News" of September 22, 1943: "THE RUINS of the Pulkovo Observatory, near Leningrad, which, although it was never captured by the German fascist invaders, has been almost completely demolished by Nazi air and artillery bombardment."

The Telluric Oxygen Bands

By Keivin Burns, *Allegheny Observatory*

IN THE first quarter of the last century Fraunhofer was searching for sharply defined colors to be used in designing achromatic telescope lenses. While engaged in this investigation he mapped those lines in the solar spectrum which were recognizable with the small resolving power at his disposal; Figure 1 is copied from a reproduction of his original map of the solar spectrum. Since that time the absorption lines of the solar spectrum have been called *Fraunhofer* lines. He designated the most prominent lines by the letters of the alphabet, beginning at the red end of the spectrum. His A and B lines, however, turn out to be bands rather than single lines; they are composed of multitudes of lines. The "A" and "B" of Figure 2 are high-resolution photographs of the bands similarly designated in Figure 1.

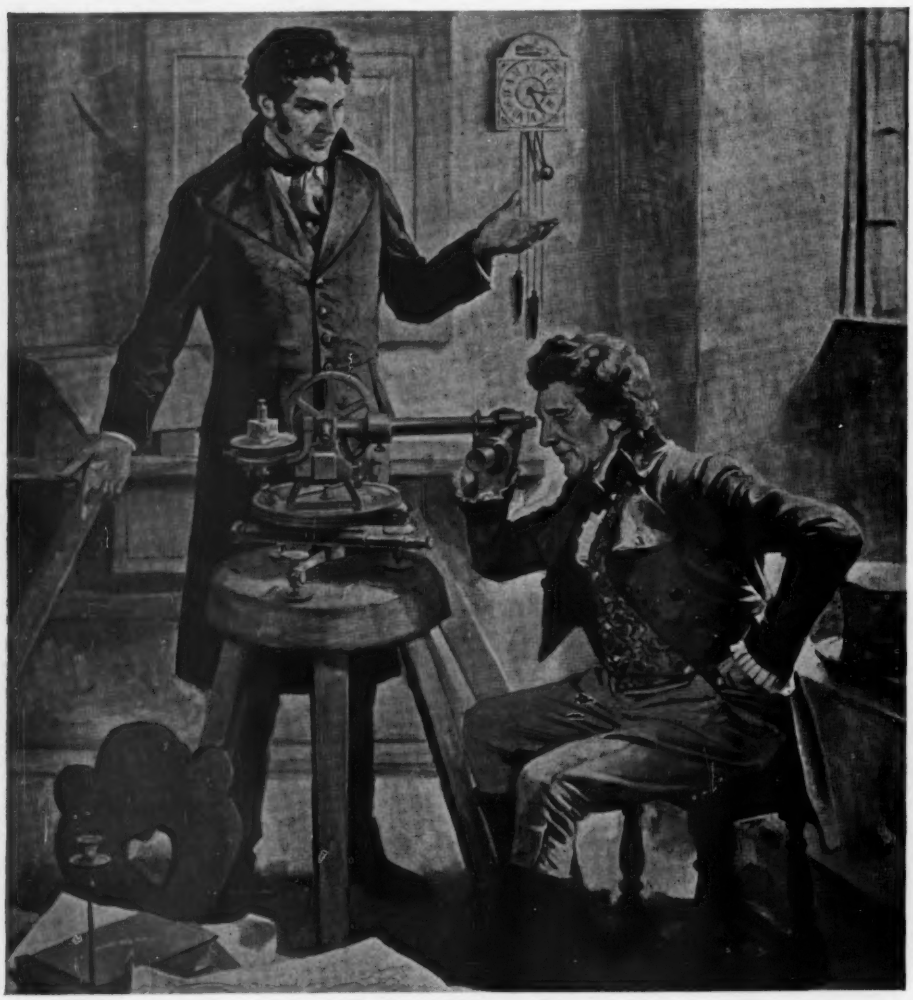
Increase in the resolving power and perfection of telescopes, and finally the introduction of photography, permitted the recording of many lines weaker or closer together than those known before 1840. After 1860, following the work of Kirchhoff and Bunsen on laboratory spectra, it was found that many of the solar lines could be accounted for by the presence of our common elements (sodium, iron, magnesium, and so forth) in the atmosphere of the sun. Other Fraunhofer lines varied in intensity with the weather; by comparing solar spectra photographed through warm, moist air with those taken on dry days, it was shown that these lines arose from water vapor in the earth's atmosphere — such lines are called *telluric* lines. One observer worked at —27°; under this condition the total possible water vapor in the atmosphere is very small indeed (1/80 of the amount at 80°F.).

But the origin of the powerful A and B bands remained in doubt for some years more. The strongest lines of these bands are pretty well saturated, that is, they absorb nearly all the incident light of their wave lengths, even if one observes a high sun from a mountaintop. Some of the best observers of the 1870's thought that the bands might be partly solar and partly telluric. No one had taken spectra similar to those of α in Figure 2, which shows the spectrum of the east limb of the sun (approaching us) in the central strip, the west limb (receding) in the two outside strips. The relative recession and approach of the west and east limbs results from the solar rotation, so that the real solar lines appear shifted to the left in the central strip; the telluric lines remain, of course, unaffected by motion in the sun.

After the use of the electric arc for illumination, Egaroff, in 1881, observed the spectrum of an arc light at night from a distance of some miles and found the A and B bands present, proving definitely that they are of terrestrial origin. Two years later this same observer compared the absorption spectrum of air and of oxygen in a long tube and showed that the A and B bands are associated with oxygen. The strong pairs of lines which Figure 2 shows as composing the A and B bands are believed to originate from the ordinary oxygen molecule made up of two oxygen atoms of atomic weight 16.

The bottom part of A in Figure 2, however, is a shorter exposure of the A band showing some of the weak lines which are visible between the broad pairs of this band. These weak lines belong to the A′ band discussed by Babcock, who confirmed the supposition that the oxygen molecules giving rise to this band are each made up of one atom of the most plentiful type of this element (atomic weight 16) and one atom of a heavier isotope which is present as a trace in our atmosphere. These sharp lines can be measured with high accuracy unless bothered by real solar lines or by the strong members of the A band.

Some 150 of these lines have been measured by interference methods in the course of setting up a system of standard solar wave lengths, a project undertaken at the request of the International Astronomical Union. It seems to be of interest to see whether or not the regularities of these series of lines can be used to test the accuracy of measurement which has been attained; and if so, how great is this accuracy. It may be stated at once that *absolute* error of scale cannot be found in this manner, but the *relative* accuracy of lines of about the same intensity throughout a limited range of spectrum can be determined with cer-



A Bausch and Lomb painting portrays Fraunhofer explaining his studies of the solar spectrum to a friend.

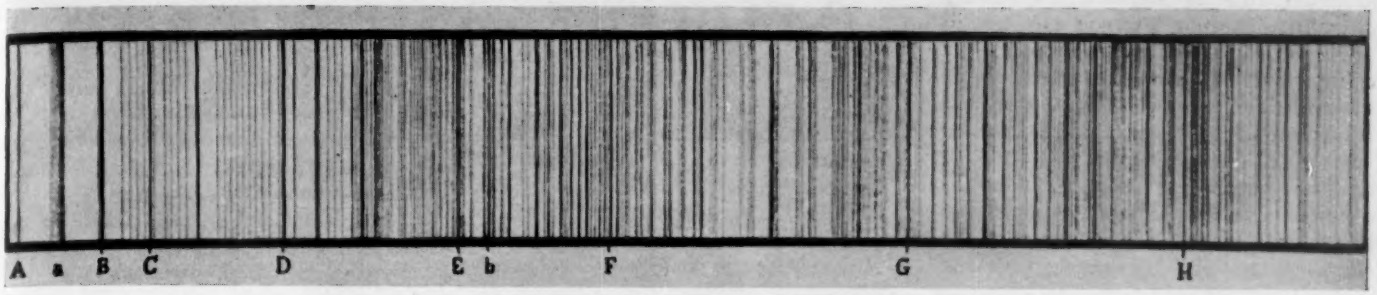


Fig. 1. A copy of Fraunhofer's original map of the solar spectrum.

tainty. The wave lengths used in this discussion have been published by Babcock and others at Mount Wilson, by Kiess, and by Sullivan; unpublished measurements by Meggers and the staff of the Allegheny Observatory were also available.

The arrangement of the lines to the right of zero in Figure 2 suggests that the wave lengths can be represented by means of a relatively simple formula. This is not evident for the lines to the left of zero, since these branches double back, the A band at number 30, the B at 24, and the α at 18. Each band, A, B, and α, consists of four branches, two of longer wave length and two of shorter waves than the zero. These have been designated as P_1, P_2, and R_1, R_2. The formulas used to represent all four branches are really equally simple, as shown by the provisional formulas for the P_1 and R_1 branches of the B band given below. Wave numbers (n)[1] are

$$P_1: \quad n = 14524.246 - 28774J - 0.0643J^2 - 0.00000026J^4.$$

$$R_1: \quad n = 14524.248 + 2.8773J - 0.0650J^2 - 0.00000095J^4.$$

[1]Wave number is the reciprocal of wave length, and gives the number of waves per unit of length, i.e., per centimeter (in a vacuum).

represented here rather than wave lengths, since this allows the simplest method of computing.

Here $J = 0.5, 2.5$, etc.; the odd numbered lines in these strong lines are missing.

It is seen that the zero (not a real line) is the same (within the observational accuracy $-.002n = 1/7{,}000{,}000$ of $1/50{,}000$ of an inch) for both branches; the coefficient of J is nearly the same but of opposite sign; the coefficient of J^2 differs by one per cent. This last-mentioned difference, though small, is important; no two branches can be represented within the error of observation by means of the same coefficient of J^2. The use of a term in J^4 is of significance only in case of J's greater than 20 and its value is quite uncertain. In fact, a term in J^3 would do just as well. Scores of investigators have derived formulas for the representation of these lines; Lester proposed and used a formula similar to those above. This differs from the classic general formula of Deslandres by having a term in the first power of the running number J. More recent discussions of these bands have been made by Dieke and Babcock, by Babcock, and by Mulliken.

Referring now to the weak but sharp lines of the A′ band, the members of its P_1 branch fit the formula: $n = 13120.378 - 2.76154J - 0.0435188J^2$, with full accuracy of measurement, the greatest departure being one part in seven million. Here there is a line for each numbered J, where $J = 1, 2, 3$, and so forth. If, however, instead of assigning the number 1 to the first line of the series, we are willing to choose a larger number having seven significant figures, then the preceding formula may be written: $n = 13164.0869 - 0.0435188J^2$, where $J = 31.72812, 32.72812$, etc. There is now no term in the first power of J while the coefficient of J^2 is the same as before. This might be called a modified Deslandres formula.

There is room for doubting the wisdom of attempting to evaluate the accuracy of a series of wave lengths by means of an arbitrary formula, such as one of the foregoing, though it is evident that a single large error in the middle of the series could not escape detection. Another method of procedure is free from this objection because it is a matter of observation which must be taken into account whether one works by arbitrary formulas or by the most complete theory. For any running number J, one finds a line in each of the four branches of A, B, α, and α'. (α' is not shown in Figure 2.) Let us choose $J = 6$, and use the observed wave numbers (published as wave lengths) for the corre-

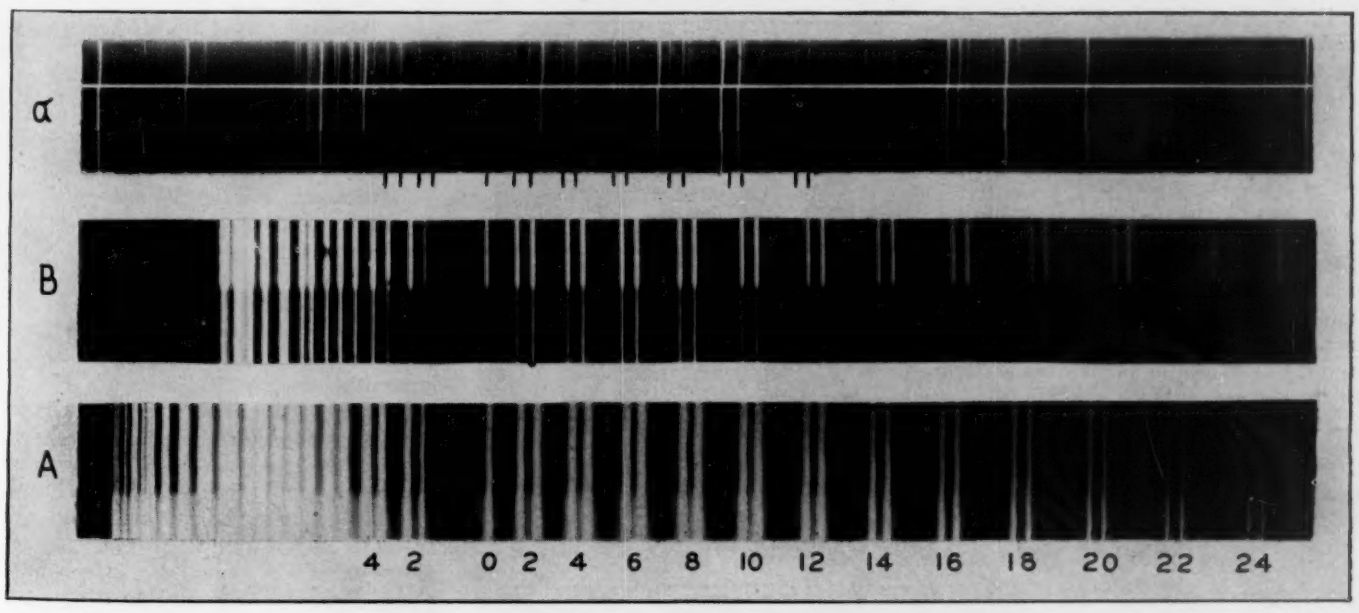


Fig. 2. The A, B, and α bands of O^2, photographed at the Allegheny Observatory.

sponding line of each of these four branches, obtaining 16 wave numbers in all, eight of which are shown in the columns under A and B in the table shown below. Next, let us subtract the wave number of each line in the A band from that of the homologous line in each of the other bands, giving us the differences in the three other columns of the table. These differences are nearly the same for all four lines in each set.

In the A, B, and α bands, we have over 130 differences like those in the table and free from blending; a study of these indicates that the relative error of the wave lengths of the lines in the A band is about one part in five million on the average; the B and α lines have been somewhat more accurately observed than that. We cannot tell by what systematic error any or all bands may be affected. It is gratifying to find that the relative errors are no greater than is indicated by the internal agreement of the individual measurements we have made.

According to theory, the lines of atomic spectra are represented as arising from electronic transitions between states of higher and lower energy, the changes being accompanied by the emission of radiation of definite frequencies. Molecular spectra may arise from somewhat analogous changes in the states of rotation and vibration. Regardless of whether or not we are representing energy changes, the differences in the table indicate that the lines in these bands may be represented as differences between a set of low levels, which is the same for all bands, and a series of high levels for each band.

The α' band consists of weak lines which have not been remeasured since Rowland. Only 20 of them appear to be unaffected by neighboring or overlapping real solar lines. So we cannot say much about the accuracy of Rowland's wave lengths of the lines in the α' band because the errors may be entirely due to blending.

It would be possible to observe the α' band at night in the spectrum of a distant source and free of blending with solar lines. Wave lengths of the weakest lines in the other telluric bands could be improved in this manner. And by observing a neighboring source, the overstrong lines at the beginning of the A and B bands could be studied to advantage. Until this has been done, any representation of the band lines as level differences can only be provisional.

	A	B	B—A	α—A	α'—A
P_1	13098.836	14502.825	1403.989	2779.983	4127.862
P_2	13100.814	14504.799	.985	.985	.856
R_1	13136.208	14540.198	.990	.980	.864
R_2	13138.198	14542.185	.987	.979	.879
Mean			.988	.982	.865

ED. NOTE: The following references may be useful:

Deslandres. See H. Kayser's *Handbuch der Spectroscopie*, Vol. II, p. 474 ff. for references to articles published before 1902.

Dieke and Babcock, *Proceedings*, National Academy of Sciences, *13*, 670-678, 1927.

Babcock, ibid, *15*, 471-477, 1929.

Mulliken, *Physical Review*, *32*, 880 ff., 1928; *Review of Modern Physics*, *4*, 1 ff., 1932.

Condon and Shortley, *The Theory of Atomic Spectra*, Cambridge Univ. Press, 1935.

Amateur Astronomers

THIS MONTH'S LECTURES

Cincinnati: At the meeting of the Cincinnati Astronomical Association on Saturday, April 29th, the annual Star-Gaze will be held, at which telescopes will be available for public use. Visitors are welcome at all meetings of the society, and the public is especially invited to this gathering. Meet at the end of the Fairview car line at 8:00 o'clock.

Cleveland: On April 21st at 8:00 p.m., Dr. S. W. McCuskey, of the Warner and Swasey Observatory, will speak on "Eclipsing Binaries" at the Cleveland Astronomical Society meeting, to be held at the Warner and Swasey Observatory.

Public nights are announced for Thursday and Friday, April 13th and 14th, at the Warner and Swasey Observatory. The building will be open at 8 o'clock, with a lecture on "The Pioneers in Astronomy" at 8:30. Observation through the telescope will follow the lecture. For reservations, call GArfield 6680.

Detroit: Dr. Karel Hujer, of the physics department at Michigan State College, will address the Detroit Astronomical Society on "The Wonders of Our Universe Through the World's Largest Telescope," on Sunday, April 16th, at 3 p.m. The meeting will be held at Wayne University.

New York: Armand N. Spitz, of The Franklin Institute, will talk before the Amateur Astronomers Association meeting on April 5th. His topic will be "The Non-Professional in Astronomy." The public is invited to all lectures, which are held at 8:00 p.m., in the American Museum of Natural History. The sixth annual dinner of the society is scheduled for April 19th; for information address George V. Plachy, secretary of the association, at the museum.

Special attention is called to a correction in the announced date of the annual meeting, which will be held on May 17th, at the museum.

Philadelphia: "The Construction of the 200-inch Telescope" will be discussed by Rein P. Kroon, a Westinghouse engineer, at the meeting of the Rittenhouse Astronomical Society on April 14th. The meeting will be held at 8:00 p.m., at the Academy of Natural Sciences.

Washington, D. C.: At the meeting of the National Capital Amateur Astronomers Association on Saturday, April 1st, Dr. Paul Herget, of the Nautical Almanac Office at the U.S. Naval Observatory, will speak on the satellites of Jupiter.

NEW HAVEN ACTIVITIES

THE JANUARY dinner meeting of the New Haven Amateur Astronomical Society served to mark the seventh anniversary of the group. Dr. Dirk Brouwer, director of Yale Observatory, spoke on "The Clouds of Magellan." The great importance of the Clouds lies in the fact that they are isolated from the Milky Way system, but near enough to permit study of their brighter stars, from the brightest ones down to stars about 10 to 100 times as luminous as the sun. Mentioning that the subject for his talk had been suggested by the recent appearance of *Galaxies*, the new book by Harlow Shapley in which the Clouds are treated in detail, Dr. Brouwer went on to discuss studies made of the Clouds and of various objects in them.

"Yale's Southern Station" was the topic of the February meeting, at which Miss Ida Barney, an astronomer at Yale, spoke about the observatory at Johannesburg, and the work done there. A model of the 26-inch refractor at the southern station, constructed on a scale of 1 to 18, was exhibited. Parallax work on southern stars, which up to the dedication of the instrument in 1925 had not been well undertaken, has been an important part of the program of the observatory. To date, 16,000 parallaxes have been determined at Johannesburg. The southern station is a memorial to the ability and foresight of Dr. Frank Schlesinger, Miss Barney said, and one result of its program is that the number of parallaxes known are now more evenly balanced for the northern and southern skies.

BEGINNER'S PAGE

Man and His Expanding Universe — V

By Percy W. Witherell

EUDOXUS, about 400 B.C., endeavored to explain the motions of the celestial bodies by the combined motions of several spheres revolving in different directions. The sun and moon each had three spheres, one revolving around the earth's axis for the daily motion; the second revolved in a contrary direction around the poles of the ecliptic for the annual and monthly revolutions, and the third revolved around an axis perpendicular to the first to take care of the motions of the sun or moon to the north and south. The five planets each needed, in addition, a fourth sphere to explain their apparent retrograde or westward movements. Another sphere took care of the fixed stars.

For a time these 27 spheres seemed to explain everything. This system was more complicated than the original nine spheres of earlier days, and of which Milton wrote:

Ring out, ye crystal spheres,
Once bless our human ears,
If ye have power to touch our senses so;
And let your silver chime
Move in melodious time,
And let the base of heav'ns deep organ blow;
And with your ninefold harmony
Make up full consort to the angelic symphony.

Apollonius of Perga attempted to clarify this situation by introducing deferents and epicycles. He accepted the ancient belief that a pure heavenly body must move in a perfect circle. His theory was that a point called a deferent moved with uniform speed along this circular orbit: the planet moved with uniform velocity around this deferent in an epicycle, another perfect circle.

Hipparchus then took care of another difficulty, that of the inequality of the two halves of the year, by putting the center of the sun's circle at a little distance away from the center of the earth.

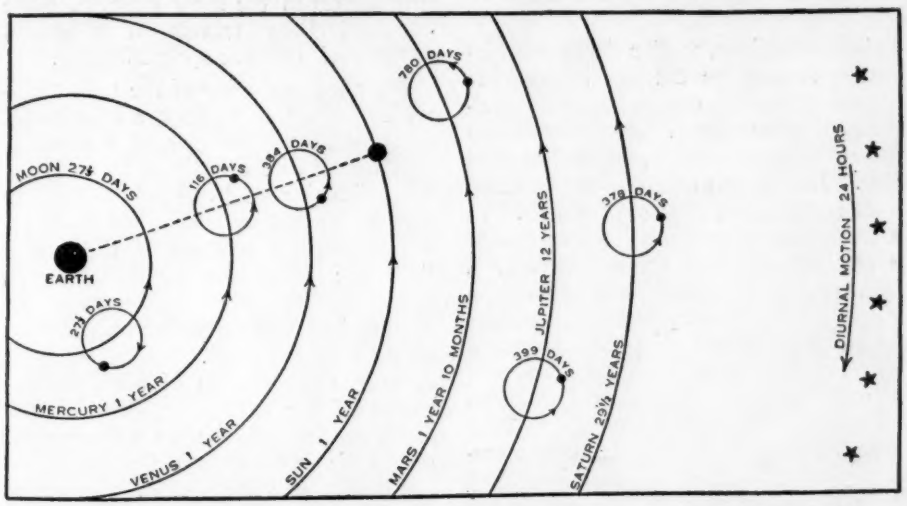
Ptolemy supposed a planet described an epicycle by a uniform revolution in a circle, the center of which was carried forward at a uniform velocity in an eccentric round the earth. By assigning proper proportions between the radii of the deferent circle and the epicycle, and between the velocity of the deferent and the planet, he was able to represent the motions of the planets, and especially their positions and retrograde motions, with fair accuracy. This systematic form given to the ideas of the originators is known as the Ptolemaic system of the universe. Unfortunately, as better observations showed more and more unexplained motions, more and more epicycles had to be introduced, until the number reached 77 before the geocentric theory was finally abandoned in the 17th century.

Although this complicated system was ultimately proven to be in error, it pleased the minds of the learned by its ingenuity. However, some discoveries were made in the early days that have stood the test of time.

Hipparchus of Nicaea invented trigonometry, established the circles of latitude and longitude, determined the length of the tropical and sidereal years, the synodic periods of the five known planets, the moon's path and horizontal parallax, the eccentricity of the sun's orbit, and the inclination of the ecliptic. He made a catalogue of over 1,000 stars, and on comparing his charts with those of Timocharis made 150 years earlier, he discovered a displacement in their positions. From this he derived the precession of the equinoxes.

Hipparchus demonstrated methods of solving plane and spherical triangles, and prepared a table of chords which he used in his calculations nearly as conveniently as a table of sines is utilized at the present time.

Ptolemy compiled a collection of the astronomical knowledge of his time in the "mathematical composition." The Arabs made a translation, prefixed their definite article, *al,* to the Greek *magest* (greatest), to distinguish it from his other works, and it has come down to us as the *Almagest.* Although Ptolemy mentions "my observations," there is some doubt as to the actual number made by him personally. Nevertheless, he stood alone without rivals, and the theories promulgated by Ptolemy were accepted for over 15 centuries.



In the Ptolemaic system, pictured here, the planets moved around the earth in their respective sidereal periods, and in small epicycles in their synodic periods.

YAKIMA AMATEURS MEET

At the February meeting of the Yakima Amateur Astronomers Club, Orris Thompson, president of the group, presented diagrams and information on the major winter constellations. An astronomy object test was another event of the evening. A number of copies of *Sky and Telescope* were opened to pictures of objects in the heavens, some familiar, and some harder to identify. The magazines were placed about the room with the captions covered and each picture numbered. Each guest was given a card and asked to write the names of the objects. The game was both interesting and educational.

Constellation study and observation with a richest-field telescope concluded the evening's program. This is the ninth year of activity of the club. Fifteen members were present at this latest meeting. C. J. GHORMLEY

PORTLAND, ORE.

Attendance at the meetings of the Astronomy Study Group of Portland is keeping up very well, reports H. J. Carruthers, in spite of the press of war work in this busy city. Officers of the group elected in January are Charles Benson, president; Mrs. Frank Bartlett, secretary-treasurer; and Mr. Carruthers, vice-president.

WEST COAST RADIO TALKS

A series of popular astronomical talks by Prof. Earle G. Linsley will be broadcast over KLX, Oakland, Cal., on April 4th, May 2nd, June 6th, and July 5th, according to the Eastbay Astronomical Association *Bulletin.* Presented by the Dial Club, which meets from 12 noon to 12:30, the programs are of the informal, round-table type, with questions and answers, and listeners are invited to send in questions.

The Ch
THE RA

By W. CRL
Director, University of Mic

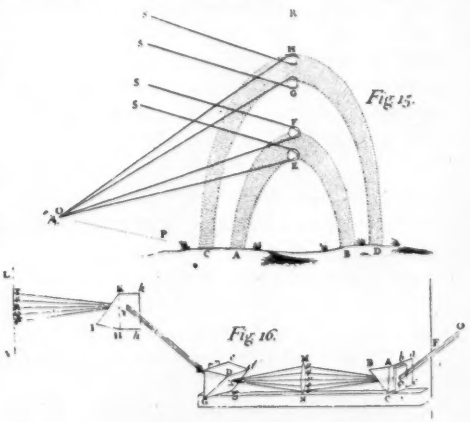
The primary and secondary bows, with supernumerary bows inside the primary. Photo by G. A. Clarke at Aberdeen, Scotland, October 2, 1919.

THE RAINBOW was the first spectrum observed by man. Its seven beautiful colors — red, orange, yellow, green, blue, indigo, and violet — arching the sky, have incited the imagination and challenged the intellect of all ages. To the primitive mind the unexplained suggested the supernatural. Universally observed after or during a shower of rain, the colored bow became associated with the idea of flood and is frequently found in deluge stories. To the ancient Akkadian it was the jeweled necklace of Ishtar, goddess of life, held aloft in the sky after the waters had been driven back. To the Hebrew it was the divine bow of promise that the flood would not return. As showers produced both beneficial and harmful results, the rainbow became a portent both of good and of evil. Frequently met in folklore and ancient literature, it is variously styled the attendant spirit of the sun, the canopy of the rain, or the spirit serpent of the underworld that comes forth to drink from the celestial fount. Again it represents the highway of the gods and the spirits of the deceased. Its allurement and its challenge have been felt by all. Many youthful minds and not a few inexperienced feet have turned toward the imaginary pot of gold at its illusive base.

To the ancient scientist or nature philosopher, the rainbow was also a wonder and a challenge which baffled every attempt at explanation. Aristotle, one of the greatest of the Greek philosophers, erroneously ascribed it to the reflection of the sun's rays by the falling rain. Like his unscientific predecessors he associated the phenomenon with the sun and the rain, but unlike them he appealed to a natural law for its explanation. He failed, however, in this case as in many others, to give the true explanation because he did not substantiate his theory by the crucial test of experiment. He enthroned the human reason instead of nature as the arbiter of natural law. It is easy to show that reflection does not produce chromatic effects. In a homogeneous medium light travels in a straight line; one cannot see over a hill, around a corner, nor through a crooked tube. When the smooth surface of an object like a mirror is interposed in the path of a beam of light, some of the rays are bent, so an object around a corner may thus become visible. These rays are said to be reflected. By measurement it is known that all the reflected rays regardless of color are bent in the same direction. For that reason a reflection or any combination of reflections forms an image of an object true to its original color. Seneca noted that the rainbow colors were identical with those formed by a broken piece of glass. Like other writers, however, he adopted the erroneous views of Aristotle, whose great authority here as elsewhere remained unchallenged for many centuries.

In the problem of the rainbow, Vitellio (or Witelo), c. 1270, is said to have added the idea of refraction or the bending of the rays of light passing through the drops of rain. Here we find a contribution toward a true explanation. When rays of light fall upon an object, not all of them are reflected at its surface. A sufficient number to make it visible are reflected and scattered even by a highly transparent body. Some of the rays, however, enter the new medium. For example, at the surface of still water, part of the rays are reflected, while others enter the water and thus make a submerged object visible. It will be noticed, however, that the direction of the rays of light entering the water has been changed, for a straight stick partly submerged appears to be bent at the surface of the water. This is due to refraction. Reflected light still travels in the same medium, while refracted light travels in a second medium of different optical density.

Near the beginning of the 14th century, Theodoric of Vriberg, a Dominican, contributed further toward a complete explanation of the rainbow by assigning two refractions and one reflection of the rays of the sun by a spherical raindrop. He assumed a bending of the ray of light as it enters the raindrop, then an internal reflection at the opposite surface, and another refraction as it emerges on the side it entered. Here is the basis of a true explanation of the form and extent of the primary rainbow, but it seems to have fallen on unproductive soil as his works remained unrecognized until recovered by G. B. Venturi at Basel in 1814. In the meantime, others advanced similar views. During the 16th century at least two writers, John Fleischer, of Breslau, 1574, and Franciscus Mauralycus, 1575, gave the same explanation; and a little later Marco



Diagrams from Newton's "Opticks," 1704, explain the formation of the rainbow and Newton's experiment to prove that white light is composed of the rainbow colors.

Challenge of RAINBOW

W. CARL RUFUS
University of Michigan Observatories

Antonio de Dominis (1566-1624), archbishop of Spalatro, added an explanation of the secondary bow by two refractions and two internal reflections.

The beginning of the 17th century witnessed the downfall of authority in the realm of science and the rise of experimentation. During the preceding century Copernicus broke away from the astronomical system of the Greeks, who had maintained a stationary earth at the center of the universe, around which moved the sun, the moon, the planets, and the stars. He advanced the heliocentric theory, which encountered much stubborn opposition both by the scientists and the ecclesiastics, but finally won its way to acceptance as fact after fact confirmed its truth. Old laws crumbled and new laws were subjected to the newly found test of experiment and measurement.

In this new scientific spirit of the times, Kepler in his *Dioptrics,* 1611, demonstrated that sunlight passing through a prism comes out as a colored beam in the rainbow order. Here was a basis for experimentation and proof. Snell, in 1621, announced the law of refraction, $\sin i/\sin r = n$ (i is the angle of incidence, r is the angle of refraction, and the constant n is the index of refraction of the medium). Descartes approached the problem of the rainbow quantitatively or from the standpoint of measurement, which is essential in science. In 1637 he applied Snell's law of refraction to determine the radii of the two bows, the primary and the secondary. Using the index of refraction of water as 4/3, the values he obtained for the radii of the two bows agreed satisfactorily with the measured results, 41° and 57°, respectively. Marci, Grimaldi, Hooke, and Barrow discussed the question, but the colors still had no quantitative explanation.

Newton made a careful quantitative study of light refracted through a prism. He applied the term *spectrum* to the colored band produced by passing a beam of sunlight through a prism and projecting it on a screen. Introducing a second prism in the path of the colored rays he restored the light to its original color. Then to find out if the colors had been eliminated, he passed the beam through another prism and again produced a spectrum. By these processes of analysis and synthesis he concluded that "white light" is composed of the rainbow colors. He also mixed pigments of different colors and ground them in a mortar to study the combined effect. He painted sectors of a disk with different colors which he rotated rapidly to see the blended hues. By this experimental method he established a "Theory of Colors," which he published in his *Opticks* in 1704. His predecessors thought that the prism produced the colors, but Newton proved that these all existed in the composite sunlight and the prism merely dispersed them into a colored band.

Newton's work with the prism was continued and enabled him to give a complete explanation of the rainbow. He measured the angle of refraction of the light (bending from the original path) due to passage through the prism, and found it depends not only on the refractive index of the glass but also upon the color of the component parts of the light. The bending increases in the rainbow order, red, orange, yellow, green, blue, indigo, and violet. In other words, the index of refraction of the second medium, whether the glass of the prism or the spherical raindrop, is smallest for the red rays and greatest for the violet. With newly found values of these quantities, he was able not only to establish the order of the rainbow colors, but even to determine their positions and extent in the primary and secondary bows. He explained why the red is outside and the violet inside in the primary arch and why the order is reversed in the secondary. He even determined the approximate width of the bows, 2° and 3° between the red and violet edges, respectively, and thus gave the first complete scientific explanation of the rainbow which had baffled the world's leading thinkers from Aristotle to Descartes.

The challenge of the rainbow to the mind of man was successfully met by the combined efforts of many students of nature, and the phenomenon was transferred from the realm of the supernatural to the realm of science. The beautiful related myths, primitive conceptions, and ancient literary gems, that sparkle in many an illuminated manuscript and were reflected in the earliest printed pages, suddenly lost their luster. The poet Keats once proposed a toast to the confusion of Sir Isaac Newton because he had destroyed the rainbow by reducing it to a prism. The poetry of the rainbow, however, was not lost to mankind. It entered the laboratory of the scientist, lightened his days of labor, quickened his intellect, and inspired his creative imagination. It was the herald of spectrum analysis, pointing from the pot of gold at the foot of the illusive challenger to the instruments of research in the hands of the pioneers of science.

The foot of the rainbow, as photographed by Charles H. Coles near Colorado Springs, July, 1934.

GALAXIES

by

HARLOW SHAPLEY

Harvard College Observatory

(The Harvard Books on Astronomy)

GALAXIES is based on extensive information concerning stars, star clusters, and those distant external systems that resemble our own Milky Way Galaxy in content and structure. The story is unfolded in a fascinating way as the reader journeys into the vast outer spaces. It is illustrated by marvelous pictures taken by new photographic telescopes which are able to pick up interesting objects hundreds of millions of light years away. Two chapters deal with the Clouds of Magellan—presented as the toolhouse of the astronomy of galaxies. A chapter concerns the local family of galaxies, another, the Expanding Universe. Questions such as the finiteness of the universe, the time interval since the great expansion began, the total amount of material in stars, galaxies and interstellar spaces, etc., are considered.

Reviewers say:

"It would be hard to find a more authoritative book on the subject than the one called, simply, Galaxies. Everyone who knows Dr. Shapley is aware of the interesting way that he writes. That quality is fully shown in Galaxies." — Stokley, in General Electric Science Forum.

"With his facility of lucid expression and his ability to make fascinating to the man in the street the most abstruse problems of astronomy, Dr. Shapley has given us the history and progress of our knowledge of this great subject. . . . The book is abundantly illustrated from superb photographs . . . and scattered through the text are portraits of a score of astronomers who have contributed in significant ways to the progress of our knowledge of the galaxies." — Fisher, in Natural History Magazine.

126 Illus. 229 Pages.

$2.50 (1943)

The Blakiston Company

Philadelphia 5, Pa.

BOOKS AND THE SKY

BELOVED SCIENTIST

David O. Woodbury. Whittlesey House, New York, 1944. 358 pages. $3.50.

FROM the versatile pen of David O. Woodbury comes a delightfully fascinating biography of that "wizard of Lynn," the late Elihu Thomson. It is a book which holds the interest of its reader from cover to cover, so intimately are the details of the life of the "beloved scientist" described.

The story begins with the ancestral background of Elihu and his transplantation at the age of four to America, where he was to spend nearly fourscore years in study, experimentation, and development of things practical as well as theoretical.

Thomson was, in every sense of the word, a born scientist, and his contacts with other experimentalists and physicists — Edison, Helmholtz, Davy, Henry, Faraday, and others — are constantly being referred to by the author.

Before reaching his teens, Thomson was exhibiting keen interest in science, particularly in electricity. A relic of this early interest, in the shape of the "wine-bottle" electric machine, is still on exhibition at the "Thomson sanctuary" at the plant in Lynn.

Thomson entered the Central High School of Philadelphia, the equivalent of the modern college, at the age of 13, and four years later he was graduated near the head of his class. Within a few months the post of "adjunct" to the department of chemistry was offered to him, and so, the young Elihu began a career which was to bring him much renown and many honors in later life. He proved to be not only a fine experimenter, but an able teacher as well.

His chief interest was electricity, although chemistry, optics, and astronomy claimed much of his time throughout his life.

As an inventor Thomson knew how to protect the patents on his many inventions, and, as a result of a keen business mind, he was able to realize much profit from them.

His long association with the General Electric Company is clearly portrayed by the author. How "the Professor" gradually became a sort of scientific court of arbitration to his profession, and for more than 40 years maintained his office at the General Electric Works in Lynn, is fully described.

One item of especial interest to the astronomically minded reader is Thomson's enduring enthusiasm for stars and what they reveal. This is well indicated by the fact that he ground a 10-inch refracting lens and erected his own telescope at his home. Long association as a member of Harvard's Visiting Committee to the Observatory, and his relations with Percival Lowell, well attest his fondness for astronomy.

Elihu Thomson lived a well-rounded life, full of trials, to be sure, but yet replete

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Beloved Scientist should be read by all lovers of science. Perhaps the author has veered somewhat too strongly to the eulogistic side, and has overemphasized some of the details. There are some facts which have not been too well detailed. For example, the recovery of the bodies of the two youths lost in Lynn Bay is not fully and completely described. The reviewer happens to have additional details of that episode which change the aspect of the situation to some extent. Also, the reference to Dr. Harlow Shapley's letter on page 325 should obviously read "Mercurian," not "Martian."

To one who had at least a speaking acquaintance with Elihu Thomson, this book supplies many facts and incidents which tend to give him a more complete picture of that "beloved scientist."

LEON CAMPBELL
Harvard College Observatory

THE CALENDAR FOR EVERYBODY

Elisabeth Achelis. G. P. Putnam and Sons, New York, 1943. 141 pages. $1.50.

MANY phases of life and departments of business have found our present (Gregorian) calendar inadequate and have used other divisions, such as the 13-month calendar.

After many centuries of use, it is a little startling to learn of a great number of shortcomings in our calendar and to learn that what has been considered a universally accepted institution since its inception is anything but that. For example, the Gregorian calendar did not find universal acclaim in 1582, and in the case of the American colonies was not adopted until 1752. China did not adopt the Gregorian calendar until 1912; Soviet Russia accepted it in 1918 (changed to her own calendar in 1929, then changed back in 1940); and Turkey adopted it as recently as 1927.

The Calendar for Everybody is a good book to refresh your memory. In the first eight chapters, Miss Achelis tells an entertaining story, in a free style, of the development of the calendar. The real story and purpose of the book, and that portion with which the author is most closely associated, begins in Chapter IX. Miss Achelis wants a new calendar—a calendar for everybody—and she deftly shatters every objection one might have. Defects in our present calendar are revealed, the worst being its unceasing changeability: no two like years follow each other; there are four types of months which can begin on any one of the seven days of the week; therefore, our calendar seems to be a "system of 'confusion worse confounded.'"

In 1930, Miss Achelis founded the World Calendar Association. As president of this organization, she has spent most of her time promoting a simplified calendar which can be put into effect with less trouble than changing from standard time to daylight saving time. This new World calendar has the usual 12 months, but the quarters are equal in length; each quarter begins on a Sunday and ends on a Saturday, and contains three months—13 weeks—91 days. Month dates always

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Basic Air Navigation

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By LYMAN M. KELLS, WILLIS F. KERN and JAMES R. BLAND. 191 pages, $2.00.

Navigational theories are thoroughly treated in systematic, independent discussions, with a wealth of exercises graded according to difficulty. The book considers four important methods of solving a spherical triangle of which two sides and the included angle are known.

Mathematics for Navigators

By DELWYN HYATT, Commander, USN (Ret), U. S. Merchant Marine Academy, Kings Point, N. Y., and BENNETT M. DODSON, Commander, USNR, U. S. Merchant Marine Cadet Basic School, Pass Christian, Miss. 106 pages, $1.25.

Devoted exclusively to mathematical preparation for the study of navigation, this book reviews addition, subtraction, algebra, logarithms, plane geometry, plane trigonometry, and spherical trigonometry.

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fall on the same weekdays and each month has 26 weekdays, plus Sundays. Each year begins on Sunday, January 1st. The odd day in ordinary years occurs at the end of the year and would be a world holiday. In leap years, the extra (366th) day is placed at the end of June and would be a world holiday also.

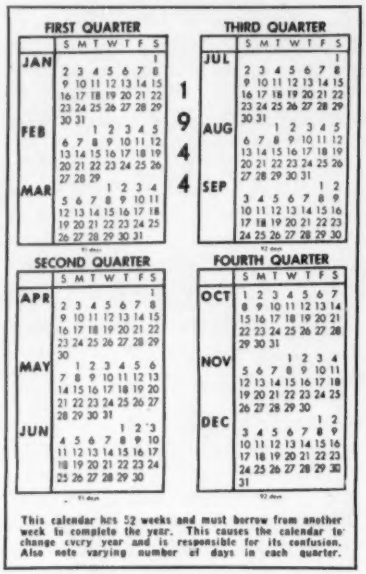
It is good that this book has been published, for it records the story of the World calendar movement, by one who knows most about it and who has worked untiringly for its adoption. Furthermore, it is well to record now, not years hence, just who is responsible for the new calendar. Miss Achelis points out that no one person is responsible. "The World Calendar gradually evolved from Switzerland first, as the result of a study made at the request of the International Congress of Chambers of Commerce in 1914, and later through the League of Nations. Many minds have contributed. As the name implies, the new calendar belongs to the world; it is world wide in purpose, usage, and possession." It now awaits adoption.

The advantages to be found in the adoption of the World calendar are set forth in Chapter XV. The disposition of holidays, Easter and others, is treated with due regard for their meaning.

There are many days upon which we could make the change from our present calendar to the new, without any interruption; no days need be dropped. July 1, 1945, March 1 and May 1, 1946, are days ideally suited to make the change; and it could take place on December 30, 1944. When the new calendar is adopted, we hope a 24-hour day will be adopted along with it. A short chronology of salient facts completes this interesting and latest book on the calendar.

R. NEWTON MAYALL
American Association of Scientific Workers

PRESENT GREGORIAN CALENDAR



EACH YEAR DIFFERENT

This calendar is always different from year to year.

The quarters are unequal in length. In leap years the first half-year has 182 days; the second, 184 days.

Each quarter begins and ends on a different day of the week.

Each month begins and ends on a different weekday.

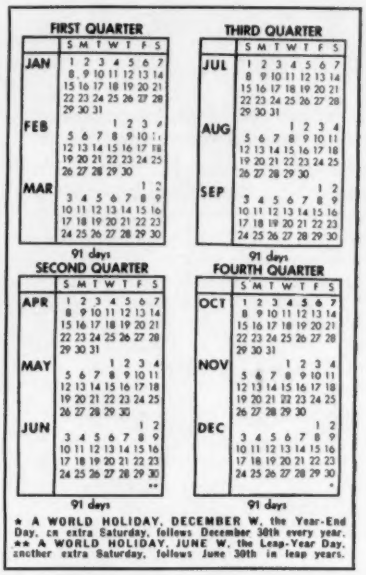
The months have a varying number of weekdays.

Each year begins on a different weekday.

This calendar is unbalanced in structure, unstable in form, and irregular in arrangement.

Its irregularity precludes comparison of periods and necessitates continued and never ceasing changes in matters routine in character.

PROPOSED WORLD CALENDAR



EACH YEAR THE SAME

This 12-month equal-quarter calendar is the same for every year.

The quarters are equal in length.

Each quarter begins on Sunday and ends on Saturday, contains 3 months—13 weeks—91 days.

Month-dates always fall on the same weekdays. Each month has 26 *weekdays*—plus Sundays.

Each year begins on Sunday, January 1, and the business year begins with Monday, January 2. Because the World Holidays precede Sunday, the usual custom of celebrating a Sunday holiday on Monday is voided.

Year-End Day and Leap-Year Day, the extra Saturdays, December W and June W, are World Holidays.

This revised calendar is balanced in structure, perpetual in form, harmonious in arrangement.

Engraving, courtesy World Calendar Association

NEW BOOKS RECEIVED

FORWARD WITH SCIENCE, *Rogers D. Rusk*, 1943, *Knopf*. 307 pages. $3.50.

The author of "Atoms, Men and Stars" discusses in popular style the amazing recent developments in science, and some of their applications in war and peace.

AN INTRODUCTION TO NAVIGATION AND NAUTICAL ASTRONOMY, *Shute, Shirk, Porter,* and *Hemenway*, 1944, *Macmillan*. 457 pages. $4.50.

An introductory text in navigation designed for service and pre-service schools. The text includes all tables and charts necessary in working the problems, and answers are given, so that a student working independently may use the book to advantage.

HERE AND THERE WITH AMATEURS

This is not intended as a complete list of societies, but rather to serve as a guide for persons near these centers, and to provide information for transplanted amateurs who may wish to visit other groups. The asterisks denote societies whose members receive *Sky and Telescope* as a privilege of membership.

City	*Organization*	*Date*	*P.M.*	*Season*	*Meeting Place*	*Communicate with*
BOSTON	*Bond Ast. Club	1st Thu.	8:15	Oct.-June	Harvard Obs.	Homer D. Ricker, Harvard Observatory
"	A.T.M.s of Boston	2nd Thu.	8:15	Sept.-June	Harvard Obs.	Ernest Smith, 158 Warwick St., Lowell
BROOKLYN, N. Y.	Astr. Dept., B'klyn Inst.	Rd. Table 3rd Thu.	8:00	Oct.-April	Brooklyn Inst.	William Henry, 154 Nassau St., N. Y. C., *BA.* 7-9473
BUFFALO	A.T.M.s & Observers	1st, 3rd Fri.	8:00	Oct.-June	Mus. of Science	J. J. Davis, Museum of Science
CHATTANOOGA	Barnard A. S.	4th Fri.	7:30	All year	Chattanooga Obs.	C. T. Jones, 1220 James Bldg., *CHat.* 6-8341
CHICAGO	*Burnham A. S.	2nd, 4th Tue.	8:00	Sept.-June	La Salle Hotel	Miss W. Sawtell, 928 N. Harvey Ave.
CINCINNATI	*Cin. A.A.	2nd Fri.	8:00	Sept.-June	Cincinnati Obs.	Dan McCarthy, 1622 DeSales Lane
CLEVELAND	Cleveland A. S.	Fri.	8:00	Sept.-June	Warner & Swasey Obs.	Mrs. Royce Parkin, The Cleveland Club
DAYTONA BEACH	D. B. Starcazers	Alt. Mon.	8:00	Nov.-June	500 S. Ridgewood Ave.	Rolland E. Stevens, 500 S. Ridgewood
DETROIT	Detroit A. S.	2nd Sun.	3:00	Sept.-June	Wayne U., Rm. 187	E. R. Phelps, Wayne University
"	Northwest A.A.S.	1st, 3rd Tue.	8:00	Sept.-June	Redford High Sch.	A. J. Walrath, 14024 Archdale Ave.
DULUTH, MINN.	Duluth Ast. Club	Meetings suspended			Darling Obs.	W. S. Telford, 126 N. 33rd Ave. E.
FT. WORTH	Tex. Observers	No regular meetings				Oscar E. Monnig, 1010 Morningside Dr.
GADSDEN, ALA.	Ala. A.A.	1st Thu.	7:30	All year	Ala. Power Audit.	Brent L. Harrell, 1176 *W* or 55
INDIANAPOLIS	Indiana A.A.	1st Sun.	2:00	All year	Central Library Audit.	E. W. Johnson, 808 Peoples Bank Bldg.
JOLIET, ILL.	Joliet A.S.	Alt. Tue.	8:00	Oct.-May	Jol. Mus. & Art Gall'y	Mrs. Robert L. Price, 403 Second Ave.
LOS ANGELES	L.A.A.S.	2nd Thu.	8:15	.....	2606 W. 8th St.	Charles Ross, 2606 W. 8th St.
LOUISVILLE, KY.	L'ville A.S.	3rd Tue.	8:00	Sept.-May	Women's Bldg., Univ. of Louisville	Mary Eberhard, 3-102 Crescent Ct. *Taylor* 4157
MADISON, WIS.	Madison A.S.	2nd Wed.	8:00	All year	Washburn Obs.	C. M. Huffer, Univ. of Wisconsin
MILWAUKEE	Milw. A.S.	1st Thu.	8:00	Oct.-May	Marquette U., Eng. Col.	E. A. Halbach, *Hopkins* 4748
MOLINE, ILL.	Pop. Ast. Club	2nd Wed.	7:30	Oct.-April	Sky Ridge Obs.	Carl H. Gamble, Route 1
NEW HAVEN	New Haven A.A.S.	4th Sat.	8:00	Sept.-June	Yale Obs.	J. J. Neale, 29 Fairmont Ave.
NEW ORLEANS	A.S. of N. Orleans	Last Wed.	8:00	Sept.-May	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
NEW YORK	*A.A.A.	1st, 3rd Wed.	8:15	Oct.-May	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., *EN.* 2-8500
"	Junior Ast. Club	Alt. Sat.	8:00	Oct.-May	Amer. Mus. Nat. Hist.	J. B. Rothschild, Hayden Plan., *EN.* 2-8500
NORFOLK, VA.	A.A.S. of Norfolk	4th Tue.	8:00	All year	Central Y.M.C.A.	P. N. Anderson, 635 W. 29th St.
NORWALK, CONN.	Norwalk Ast. Soc.	Last Fri.	8:00	Sept.-June	Private houses	Mrs. A. Hamilton, 4 Union Pk., 6-4297
OAKLAND, CAL.	Eastbay A.A.	1st Sat.	8:00	Sept.-June	Chabot Obs.	Miss H. E. Neall, 6557 Whitney St.
PHILADELPHIA	A.A. of F.I.	3rd Fri.	8:00	All year	The Franklin Inst.	Edwin F. Bailey, *Rit.* 3050
"	*Rittenhouse A.S.	2nd Fri.	8:00	Oct.-May	The Franklin Inst.	A. C. Schock, *Rit.* 3050
PITTSBURGH	*A.A.A. of P'burgh	2nd Fri.	8:00	Sept.-June	Buhl Planetarium	Louis E. Bier, 837 Estella St.
PONTIAC, MICH.	Pontiac A.A.A.	2nd Mon.	8:00	All year	Private homes	John Setlow, Jr., 593 S. Paddock St.
PORTLAND, ME.	A.S. of Maine	2nd Fri.	8:00	All year	Private homes	H. M. Harris, 27 Victory Ave., S. Portland
PORTLAND, ORE.	*Ast. Study Group	1st Wed.	8:00	All year	No. 9 Pacific Bldg.	H. J. Carruthers, 427 S. 61 Ave.
PROVIDENCE, R. I.	Skyscrapers	1st Wed.	8:00	All year	Wilson Hall, Brown U.	Ladd Obs., Brown U., *GA.* 1633
RENO, NEV.	A.S. of Nev.	4th Wed.	.....	All year	Univ. of Nevada	G. B. Blair, University of Nevada
ROCHESTER, N. Y.	Roch. Ast. Club	Alt. Fri.	8:00	Oct.-May	Univ. of Rochester	M. L. Groff, 400 University Ave.
SAN ANTONIO	San Ant. A.A.	3rd Mon.	8:00	All year	Le Villela	R. B. Poage, 807 Hammond Ave.
SAN DIEGO, CAL.	Ast. Soc. of S. D.	1st Fri.	7:30	Oct.-June	504 Elec. Bldg.	R. M. Lippert, Box 41, N. Park Sta.
SCHENECTADY	S'tady Ast. Club	3rd Mon.	8:00	All year	Observatory site	C. H. Chapman, 216 Glen Ave., Scotia
SOUTH BEND, IND.	St. Joseph Val. Ast.	Last Tue.	8:00	All year	928 Oak St.	Fannie Mae Chupp, 224 Seebirt Pl.
TACOMA, WASH.	Tacoma A.A.	1st Mon.	.....	All year	Coll. of Puget Sound	Geo. Croston, *Gar.* 4124
TULSA, OKLA.	Tulsa A.S.	2nd Tue.	.....	All year	Holland Hall	V. L. Jones, 4-8462
WASHINGTON, D.C.	Nat'l. Cap. A.A.A.	1st Sat.	8:00	Oct.-June	U. S. Nat'l. Museum	Miss D. Harris, 1621 T St., N.W., *Du.* 4200
WICHITA, KANS.	*Wichita A.S.	2nd Tue.	8:00	All year	E. High Sch., Rm. 214	S. S. Whitehead, 2322 E. Douglas, 33148
YAKIMA, WASH.	Yak. Am. Astr'mers	3rd Tue.	7:30	All year	Y.M.C.A. Lounge	C. A. Zumwalt, 1019 Pleasant

★ ★

PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium in New York City and of the Buhl Planetarium in Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents, *April 1st through 10th,* THE STORY OF EASTER.

Have you ever wondered why Easter falls on different dates in different years? The reason is astronomical, and involves a certain full moon which plays its role in the Planetarium sky as part of the beautiful and significant story of Easter.

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★ **THE HAYDEN PLANETARIUM** presents in *April,* STARS OF SPRING. (See page 3.)

In *May,* COMETS AND METEORS. These strange bodies come and go in a most unpredictable way. Their vagaries brought them into disrepute. They are still mysterious even though we now understand many of their properties. Bright comets are rare, but there are many dim ones discovered. Even the story of a comet discovery and its confirmation is interesting. Finding meteorites is important, too.

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THE BOOK CORNER

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GLEANINGS FOR A. T. M.s

Improving the Reflector

THE ADDRESS of F. J. Hargreaves, F.C.I.P.A., president of the British Astronomical Association, at their recent general meeting, again brings up the question of relative performance of reflecting and refracting telescopes. It seems to be commonly accepted that the image definition of a reflecting telescope is inferior to that of a refractor of equal aperture, but there seems to be no valid theoretical reason why this should be so.

There are seven factors which probably contribute to the situation. Mr. Hargreaves comments on these as follows:

1. "A mirror depends for its performance on the shape or figure of the single surface from which the light is reflected. An object-glass has four surfaces through which the light is refracted, and it can be shown that an error of figure in a reflecting surface has three times as much effect on the image as an equal error in a refracting surface. Because errors in the four successive refracting surfaces of an object-glass are as likely to reinforce one another as to cancel one another, it might be expected that, other things being equal, the images produced by object-glasses would be about as much affected by errors of figure as those produced by mirrors.

"Other things, however, are not equal: the mirror will usually be only about half the focal length of the object-glass. This undoubtedly makes it necessary to figure the surface of the mirror a good deal more accurately than the surfaces of the object-glass, to obtain equal performance.

"It does not follow from this that a mirror must necessarily be inferior to an object-glass of the same aperture, because errors in an optical surface which are less than a certain definite value have no effect at all on the image, and this degree of accuracy, beyond which it is not necessary to go, is easily attainable. It is possible, in fact, to work both object-glasses and mirrors, up to 14 or 15 inches aperture at least, so accurately that the image formed by them is indistinguishable from the theoretically perfect image. Not only is this possible, but it is not really difficult. Most of the mirrors made by the great opticians of the past, such as With and Calver, are of this quality, and equally good mirrors are still being made by some of their successors."

He who is tempted to let a mirror go which is "good enough" should be warned by the above. What Mr. Hargreaves says about the possibility of making mirrors of high quality is perfectly true — it is also true, we say with regret, that the average amateur product does not measure up to the highest standards of perfection.

2. "In a reflector, however, the light has to traverse the full length of the tube before reaching the mirror, and then returns along the tube, which is necessarily open at its upper end. The air in this tube is usually slightly warmer than that outside and it therefore tends to stream upwards and to be displaced by cooler air streaming in. The result is a confused mixture of slowly moving currents of air at different densities, and the effect on the image is deplorable; it is blurred, unsteady and generally unsatisfactory.

"The remedy is to use an electric fan to blow a brisk current of air through the tube. If this cannot be done, the next best thing is to use a 'skeleton' or lattice-work tube.

"A further trouble is caused by a thin layer of air warmed (or rather prevented from cooling) by the mirror, which seems to cling to the surface and, being non-uniform in thickness and density, further spoils the definition.

"The remedy for this is to blow a current of air across the face of the mirror. A single fan could be used to serve both purposes if a deflector is arranged so that the air first blows across the mirror and is then deflected up the tube. Failing this, a separate fan may be used."

3. "After having passed twice along the tube, the light encounters the diagonal, the surface of which is supposed to be plane. I have already pointed out the importance of this small mirror, and so have other writers. Most diagonals belonging to existing telescopes that I have tested have been far from perfect, and some have been very bad indeed. Perhaps this is the most serious cause of poor performance in reflectors, because it is the most difficult to remedy."

From an optical point of view, the elliptical flat is superior to the prism. It must, however, be optically finished and properly mounted. There is no reason, however, why this should not always be the case. It would be false economy not to equal the high standards of the mirror when selecting or making a diagonal for the telescope.

(*To be continued*)

A FILM SUBSTITUTE

Since there has been a serious film shortage in our part of the country, it seemed that it would put an end to our astronomical photography. Recently, I

SKY-GAZERS EXCHANGE

Classified advertisements are accepted for this column at 30c a line per insertion, 7 words to the line. Minimum ad 3 lines. Remittance must accompany orders. Address Ad Dept., Sky and Telescope, Harvard College Observatory, Cambridge 38, Mass.

FOR SALE: 6" refracting telescope, equatorial with circles, 7 oculars 50 to 280 powers. 1 grated positive ocular; 1 sun and 1 star diagonal; 1¼" finder with diagonal; spring motor and extra fine tripod. $600.00. Write W. H. Raith, 17 Shephard Avenue, Newark, N. J.

FOR SALE: 50x7 Zeiss binoculars with case, good condition, $165.00. Mounted 90° star diagonal prism. Miscellaneous telescope makers items. W. Griffin, 2012 Hilton Road, Cleveland 12, Ohio.

WANTED: 1/3" eyepiece; setting circles about 6" diameter; 6" glass speculum; can exchange 6" equatorial mount. Raymond Schmidt, Chloride, N. M.

FOR SALE: 2½" achromatic astronomical telescope on tall tripod, with one celestial eyepiece, magnifying 35x. Gilbert Friedman, 1644 Anthony Ave., New York 57, N. Y.

WANTED: to buy, a 5" achromatic objective lens or glasses to grind same. C. Dripps, 7618 Frankstown Ave., Pittsburgh, Pa.

EDITED BY EARLE B. BROWN

noticed a magazine article about using enlarging paper instead of film. Well, we tried it in my 3-inch refractor with surprisingly good results. [Prints enclosed of the moon, Venus, and Jupiter **are** "surprisingly good."] Though the pictures are quite coarse in tone and are negatives on paper, positives may be made, but I like the negatives better since there is not so much loss in detail.

This enlarging paper is quite fast, needing only a few more seconds for the moon to a couple of extra minutes for the brighter planets. I tried photographing stars, but these do not come out as well since they are only points of light and are quite coarse on the paper. When film comes back, I will probably go back to it for sharp contrast and good detail.

GEORGE F. PETERSON
1341 College Avenue
Racine, Wis.

NEWS FROM MOSCOW

(*Continued from page 7*)

est at the conference was that of Professor S. V. Orlov [winner of a Stalin prize] on the classification of comets. Professor Orlov's work explains hitherto completely unknown phenomena in the heads of comets. By general recognition his research is a valuable contribution to science.

Academician Fesenkov, chairman of the commission that studied the solar eclipse of September 21, 1941, summarized the work on the observation data and told of the main scientific results obtained. Thanks to timely and thorough preparation, the observations were carried out despite the war, which greatly hampered the shipment of apparatus and the arrival of the members of the expeditions. The entire program of observations was in the main realized.

After his report, which was the concluding one of the conference, Academician Fesenkov called upon the astronomical institutions of the country to begin preparing for the July 9, 1945, eclipse, which will be visible in many points of the Soviet Union.

NOTICE

EFFECTIVE with both new and renewal subscriptions after April 1st, the price of Sky and Telescope is increased to $2.50 per year for the United States and possessions, including service men and women overseas; to $3.00 per year for Canada and countries in the Pan-American Postal Union; and to $3.50 per year for all other foreign countries. The single copy sales price is increased to 25 cents. Bound sets of Volume II are $5.50.

SKY PUBLISHING CORPORATION
Harvard College Observatory
Cambridge 38, Mass.

ASTRONOMICAL ANECDOTES

ASTRONOMERS AS CONJURERS, AND EXTRACTS FROM A DIARY

AUGUSTUS DE MORGAN related some anecdotes which are probably worth perpetuating. It is often stated that Flamsteed practiced astrology, and one of the stories is told by De Morgan, who stated that he wouldn't vouch for it.

"Sometimes the astronomer turns conjurer for fun, and his prophesies are fulfilled. It is related of Flamsteed that an old woman came to know the whereabouts of a bundle of linen which had strayed. Flamsteed drew a circle, put a square into it, and gravely pointed out a ditch, near her cottage, in which he said it would be found. He meant to have given the woman a little good advice when she came back; but she came back in great delight, with the bundle in her hand, found in the very place."

Another story De Morgan told is vaguely connected with the things we had in last month's installment: "The late Baron Zach (1754-1832, director of the observatory at Seeberge near Gotha) received a letter from Pons (1761-1831, discoverer of 37 comets between 1801 and 1827), a successful finder of comets, complaining that for a certain period he had found no comets, though he had searched diligently. Zach, a man of much sly humor, told him that no spots had been seen on the sun for about the same time — which was true — and assured him that when the spots came back the comets would come with them. Some time after he got a letter from Pons, who informed him with great satisfaction that he was quite right, that very large spots had appeared on the sun, and that he had found a fine comet shortly after. I have the story in Zach's handwriting."

Some extracts from a diary: 1881, August 16 . . . We rose above the entire timber belt, and at five o'clock we reached camp at an elevation of about 12,000 feet. It was beautifully placed on a nearly circular and well-watered meadow about 200 yards in diameter, while an amphitheater of very precipitous cliffs from 1000 to 1500 feet, forming the base and flank of Whitney Peak, rose immediately from its northern and eastern sides.

August 19 . . . The sky today, as always, is of the most deep violet blue, such as we never, under any circumstances, see near the sea-level. It is absolutely cloudless, and there is only a slight orange tint about the horizon at sunset. Carrying a screen in the hand between the eye and the sun, till the eye is shaded from the direct rays, it can follow this blue up to the edge of the solar disk without finding in it any loss of this deep violet or any milkiness as it approaches the limb. It is an incomparably beautiful sky for the observer's purposes, such as I have not seen equalled in the Rocky Mountains, in Egypt, or on Mount Etna. It had been part of my object to make an effort to see the solar corona by directly cutting off the sun's light by a very distant cliff, though I was aware that Bond had tried a similar experiment unsuccessfully in the Alps, and though I had myself been foiled in a similar attempt on Mount Etna. On the south of the camp was a range of cliffs, running nearly east and west, and whose almost perpendicular wall rose from 1000 to 1200 feet. They appeared to be within a pistol shot of the camp. I left it for them at about eleven o'clock, but reached them at nearly half-past twelve, after an hour and a half of hard scrambling. I found that I could choose a position on the north of the cliff, along whose edge the sun was moving nearly horizontally; so that the shadow was fixed as regards the observer, and so sharp that, though I must have been over one-quarter of a mile from the portion of the cliff casting it, I could, without moving from my place, and by only a slight motion of the head, put the eye in or out of view of the sun's north limb. The rocks were, in these circumstances, lined with a brilliant silver edge, due to diffraction. This I had anticipated, but now I saw what could not be seen by screening the sun with a near object, that the sky really did not maintain the same violet blue up to the sun, but that a fine coma was seen about it of about four degrees diameter, nearly uniform, though it was sensibly brighter through the diameter of 1½ degrees. Upon bringing to bear upon it an excellent portable telescope, magnifying about thirty times, I found it was composed of motes in the sunbeam, between the diffracting edge and the observer's eye. . . .

August 25 . . . A considerable portion of our apparatus had been constructed with a special view of observing the solar corona here, if possible, without an eclipse. We were engaged for the following three days with this, and just as a possibility of success seemed near, a most disheartening accident robbed us of further hope in this direction. As the attempt was unsuccessful, I will not enlarge upon it, nor describe the intended means. . . . *End of Excerpt.*

Samuel Pierpont Langley was probably never hypnotized into believing himself a minus number under a radical sign, but he should have been, for that last sentence. I don't yet know what the accident was nor how he intended to view the corona. R. K. M.

OBSERVER'S PAGE

All times mentioned on the Observer's Page are Eastern war time.

The Beehive and the Moon

By Jesse A. Fitzpatrick

THE OPEN cluster usually known as the Beehive or Praesepe, and listed in Messier's catalogue as No. 44, is situated in the constellation of Cancer at right ascension 8h 37m and about one degree north of the ecliptic. It is one of the very few really naked-eye "nebulae," and is well placed for observation at convenient hours throughout the spring.

The cluster consists of more than 300 stars, 90 per cent of which are fainter than magnitude 9.0, and its most interesting portion is contained in an area of one square degree. The brightest star, Epsilon Cancri, magnitude 6.32, is below easy naked-eye visibility, but the great number of stars in so small an area causes a glow that can easily be seen without optical aid. The group is some 500 light-years distant, about the same as the Pleiades, but different from the latter in having spectral classifications varying widely between the hot, white A0 class and the cool, orange K0 type.

As its ascending node moves westward along the ecliptic, the moon will begin to occult the stars in Praesepe during the early months of this year, but only for observers in the most southerly latitudes of our Southern Hemisphere. Those who live in mid-northern latitudes and the general longitude of the United States must wait until December to witness any of these occultations. Weather conditions permitting, however, we shall be more fortunate in the early months of 1945.

The occultations will be discussed later in this article, but since the months of April and May are excellent ones for studying this cluster during hours that are convenient for busy people, I think a brief description of some of the individual stars is in order. It is well to use the lowest possible magnification to obtain the best effect; this will give a larger field and keep the stars from being spread too far apart.

The Beehive, photographed by William Henry. Epsilon is 2¼″ from the top and 1⅝″ from the right edge. 109 B is 1$\frac{5}{16}$″ from the top and 1$\frac{1}{16}$″ from the right edge.

On the diagram I have given the usual designations for 20 of the brightest stars in the cluster. Those with four digits are in the BD classification and those with five digits are selected from the listings in the Henry Draper catalogue. Out of these 20 stars, 13 are brighter than magnitude 7, ranging from Epsilon, magnitude 6.32, to 110 B, magnitude 6.98. The star 73711, magnitude 7.4, and the three other Draper stars, together with 1991, 2136, and 2144, are between magnitudes 8.1 and 8.8.

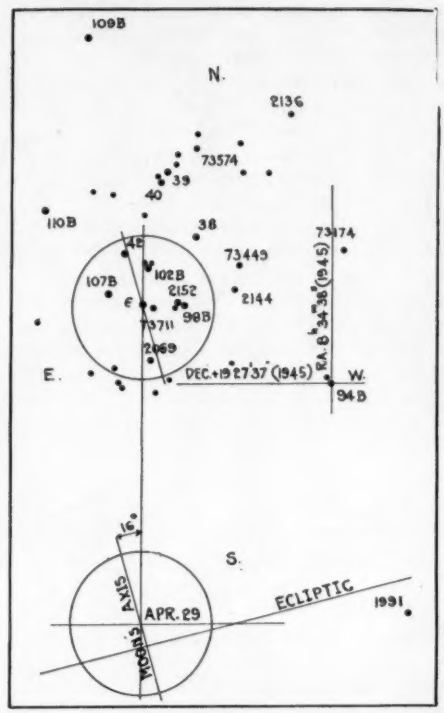
Epsilon and 73711 make an interesting pair of hot, white stars, spectral classes A2 and A0, respectively, but their separation of 143 seconds is rather large. The relative position angle is 250°. A closer pair is 2152, magnitude 6.94, spectrum A0, and 98 B, magnitude 6.68, K0. The separation in this case is 92 seconds with the position angle 241°. Here we have a definite color contrast. There is also an 8th-magnitude star in this region, 44 seconds of arc distant at position angle 156°.

Epsilon and 102 B (the latter of magnitude 6.50 and spectrum G5) move with nearly identical proper motions toward the southwest and at a speed that will carry them a distance equal to the moon's apparent diameter in 40,000 years.

At the bottom of the diagram I have shown the position of the moon, relative to the Beehive, as it will be seen from our local station at 8:44.3 p.m., April 29th. Observers in the southern part of South America will witness an occultation of Epsilon and nearby stars on that date. In New York City, Epsilon will appear north of the moon by a distance of 1.7 moon diameters, and as the position angle of the moon's axis is always 16° when the moon has this right ascension, the conjunction will be on a line drawn from the center of the moon through the crater Aristotle and extended. In our southern states the star will be closer to the moon by distances varying generally with the observer's latitude, although longitude will have some effect on this separation. The conjunction will occur very near the local meridian at New Orleans, Jackson, Miss., and St. Louis.

Approximately every 27 1/3 days the moon will return to the celestial longitude that it will have on April 29th, but because its ascending node moves westerly along the ecliptic nearly 1½ degrees during that interval, the moon will be slightly north of its previous position at each succeeding return. It will have made its eighth sidereal revolution when the upper position in the diagram is reached.

This will occur at 7:00.7 a.m., December 4th, at our local station; then the moon's center will be only 27″.5 south of Epsilon. As will be seen on the diagram, 12 bright stars will be behind the moon at that time, plus many faint ones that I have not shown. The occultations of these stars may be observed across the entire width of the United States, but due to the southeasterly direction of its path, the moon will be farther north on the West Coast than shown on the diagram. At the **Ephemeris** Standard Station in California, longitude 120° W., latitude 36° N., Epsilon will be near the moon's southern limb and 39 and 40 will have brief occultations near the northern edge. Epsilon will be in conjunction with or behind the moon's central meridian at approximately 2:30 a.m. P.W.T.



It would be interesting to observe the gradual movement of the moon to the north at the end of each sidereal revolution, but unfortunately none of its coming returns to the vicinity of Praesepe are visible in the United States except the two that I have shown on the diagram. The conjunctions in September and October occur in daylight, while that on November 6th will occur well below the eastern horizon, early in the evening on the Atlantic seaboard. However, the moon's apparent northerly motion would not appear to be uniform, as it varies with the moon's distance from the earth at each return to the same celestial longitude.

MINIMA OF ALGOL

April 1, 10:52 p.m.; 4, 7:41 p.m.

PHASES OF THE MOON

Full moon	April 8, 1:22 p.m.
Last quarter	April 16, 0:59 a.m.
New moon	April 22, 4:43 p.m.
First quarter	April 30, 2:06 a.m.

MIRA MAXIMUM IN MARCH

MIRA, the first star recognized as regularly variable in light, and astronomically designated as Omicron Ceti, has just passed through the 383rd maximum since its discovery. On January 1st of this year it was observed telescopically by variable star observers as of magnitude 8.5. It attained the 6th magnitude on January 25th, and on February 3rd was visible to the unaided eye, slightly brighter than the 5th magnitude. The brightest phase, evidently early in March, did not quite reach 4th magnitude. Although, during April, Mira is too near the sun for northerners, far southern observers can follow it for some weeks to come.

Since the period of variation of Mira is about 11 months, or 331 days, the star should again attain maximum brightness about February 1, 1945, a more favorable occasion. Curiously, the brightness at different maxima varies greatly. It has been known to reach to nearly 1st magnitude — the brightest star in Cetus — while at other maxima it has barely attained 5th magnitude, not too easily seen with the naked eye. The average maximum brightness is between magnitudes 3 and 4.

LEON CAMPBELL
Recorder, A.A.V.S.O.

OCCULTATIONS — APRIL, 1944

Local station, lat. 40° 48′.6, long. 4h 55m.8 west.

Date	Mag.	Name	Immersion	P.*	Emersion	P.*
April 2	7.5	BD +19° 1963	2:00.8 a.m.	135°		
2	7.1	BD +17° 1990	11:30.8 p.m.	117°		
5	7.3	BD +11° 2269	3:07.6 a.m.	127°		
14	6.2	30 G Sagittarii	3:25.3 a.m.	68°	4:36.4 a.m.	311°
15	3.9	Omicron Sagittarii	2:52.0 a.m.	83°	4:04.6 a.m.	287°
25	5.0	m Tauri	9:37.9 p.m.	138°	10:14.0 p.m.	216°
26	4.7	Chi² Orionis	10:01.5 p.m.	134°	10:46.3 p.m.	232°
29	5.4	85 Geminorum	0:02.4 a.m.	46°	0:38.1 a.m.	338°
29	4.2	Delta Cancri	10:50.2 p.m.	90°	11:55.7 p.m.	306°
30	—1.7	Jupiter	3:49.7 p.m.	117°	5:07.3 p.m.	265°

*P is the position angle of the point of contact on the moon's disk measured eastward from the north point.

OCCULTATIONS FOR TEXAS

PREDICTIONS are for longitude 98° 0′.0 W., and latitude 30° 0′.0 N. The data include: date, name of star, magnitude; G.C.T. in hours and minutes, **a** and **b** quantities in minutes, and position angle in degrees, at immersion; G.C.T., **a** and **b** quantities, and P.A. at emersion.

Apr. 1, 56 Gem, 5.2; 4:15.4, —1.6, —0.9, 89°; 5:29.0, —0.5, —1.8, 273°.

Apr. 1, 61 Gem, 5.9; 7:02.2, —0.3, —0.5, 71°; . . .

Apr. 14, 14 Sgr, 5.7; 11:00.0, —2.4, —0.8, 116°; 12:24.7, —2.3, +0.2, 251°.

Apr. 15, o Sgr, 3.9; 6:38.5, +0.5, —1.0, 145°; 7:19.7, —1.3, +2.5, 230°.

Apr. 28, Zeta Gem, (var.) 3.7-4.1; 4:40.0, —0.4, —1.4, 104°; . . .

Apr. 29, 85 Gem, 5.4; 3:57.6, —0.7, —1.7, 111°; 5:04.5, —0.3, —1.3, 280°.

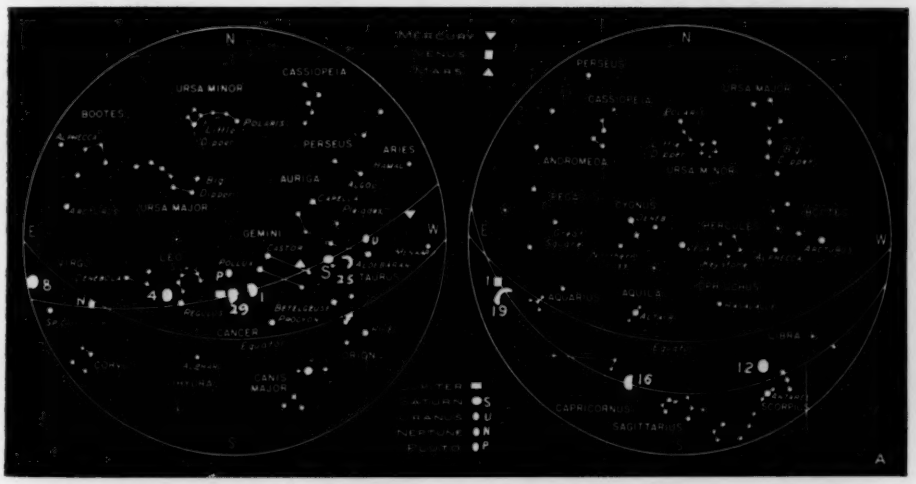
Apr. 30, Delta Cnc, 4.2; 2:49.5, —0.6, —4.0, 157°; 3:47.7, —2.2, +0.2, 245°.

Apr. 30, Jupiter, —1.7; 19:32.8, —0.6, —0.9, 141°; 20:20.2, —0.1, +2.8, 233°.

The predictions, computed voluntarily by Miss Tecla Combariati and J. Lynn Smith, of the U. S. Naval Observatory, are similar in form to those given in the **American Ephemeris** for 1944, pages 365-372.

Immersions at the dark limb (while the moon is waxing) are most desired. Reports should include the exact time of the phenomenon, and the observer's precise latitude, longitude, and elevation.

THE MOON AND PLANETS IN THE EVENING AND MORNING SKIES



In mid-northern latitudes, the sky appears as at the right at 6:30 a.m. on the 7th of the month, and at 5:30 a.m. on the 23rd. At the left is the sky for 8:30 p.m. on the 7th and for 7:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury will be at greatest eastern elongation, 19° 36′, on April 12th, setting 1½ hours after the sun. This will be a most favorable elongation for observers in the Northern Hemisphere. The planet should be easily observed for a week before and after that date. Its magnitude will be 0.2, and its path in the sky 9° north of that of the sun.

Venus will be too close to the sun in the sky to be of interest.

Mars, in Gemini, magnitude 1.4, is still a conspicuous object in the evening sky.

Jupiter, in Leo, and very close to the boundary of Cancer, will resume its progressive (eastward) motion on April 13th. It will be occulted by the moon in mid-afternoon on the 30th; the times are noted in the list of occultations. Binoculars should be sufficient to observe the immersion if the sky is clear.

Saturn, in Taurus, will be 16′ north of Omicron Tauri on April 8th.

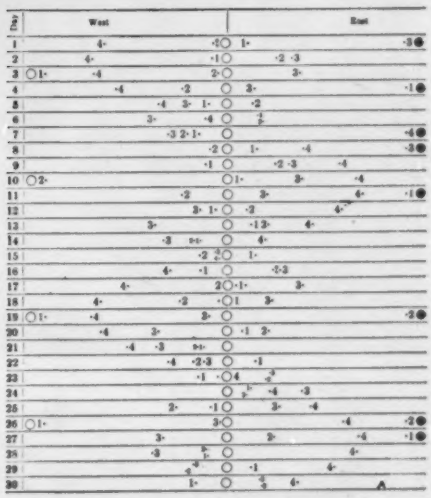
Uranus is in Taurus also; see article and diagram in the January issue.

Neptune is in Virgo; see article and diagram in the February issue.

JUPITER'S SATELLITES

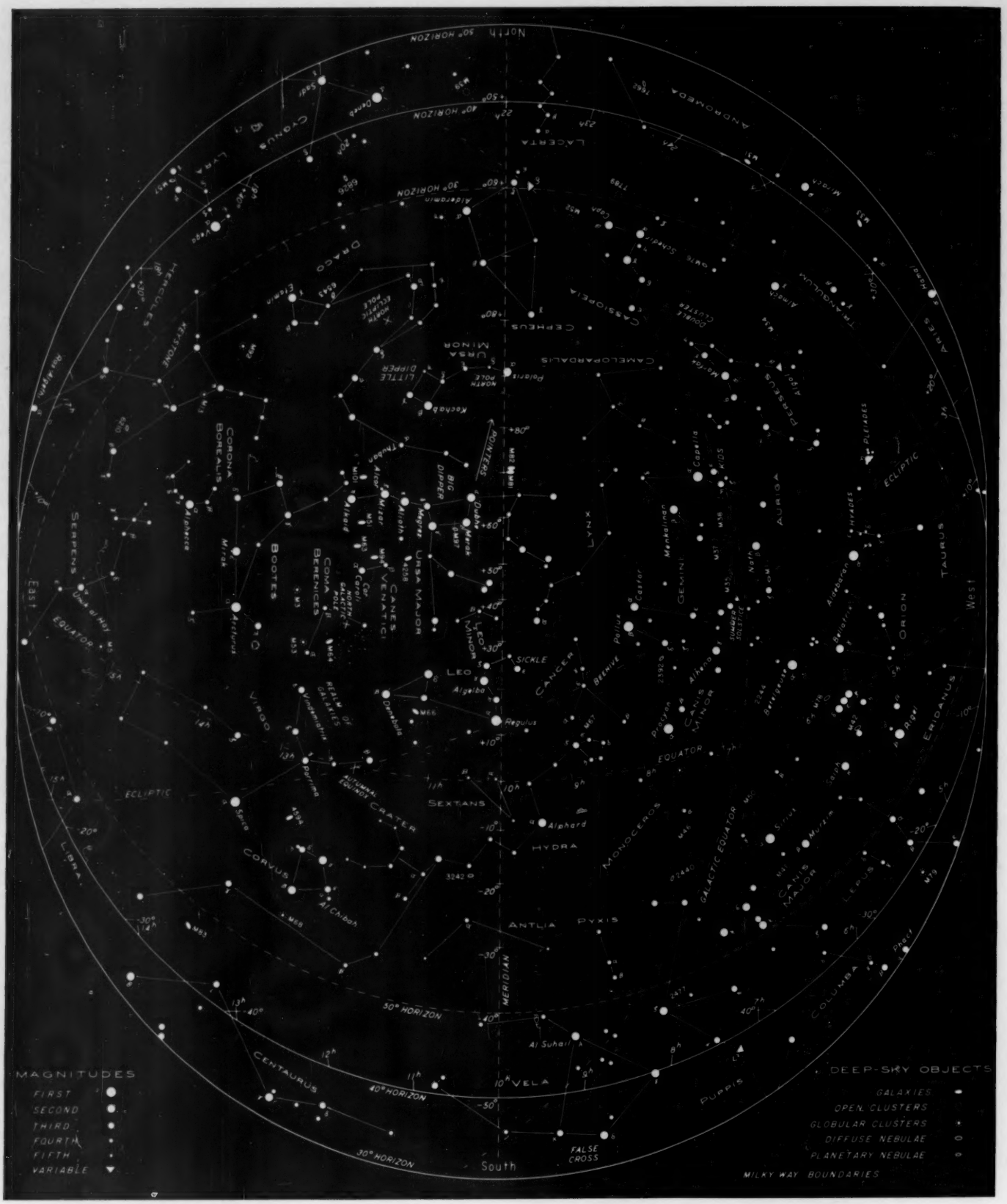
On April 9th, before 11:08 p.m., and throughout the evenings of the 23rd and 30th, the four bright moons will be east of Jupiter. On the 20th they will be on the west side and in numerical order, I being nearest the primary.

Jupiter's four bright moons have the positions shown below at 12:30 a.m., E.W.T. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the American Ephemeris.



EQUATION OF TIME

The equation of time will be zero on Saturday, April 15th, when the sun will be almost exactly due south at 1:00 p.m. war time at standard meridians in the United States.



DEEP-SKY WONDERS

AMONG marvels that the April heavens offer for observation by amateurs are the objects listed here. The informal descriptions portray appearance in common telescopes, and numbers in parentheses are shown in Norton's **Star Atlas.**

Leo. M66, $11^h\ 17^m.6$, +13° 17′; spiral, 8′ x 2′.5; mag. 9.9. Oval. Ray on one side, stars on other. In same large field with M65, which is smaller.

Gemini. NGC 2392 (45[4]), $7^h\ 26^m$, +21° 02′; small oval planetary, 20″ x 13″. Somewhat difficult; dim fuzzy spot with central star. Forms triangle with two stars. M35, $6^h\ 2^m.7$, +24° 21′; pleasing cluster of 120 stars; diameter 40′.

Monoceros. M50, $6^h\ 58^m.2$, —8° 12′; open cluster of 100 stars; diameter 16′.

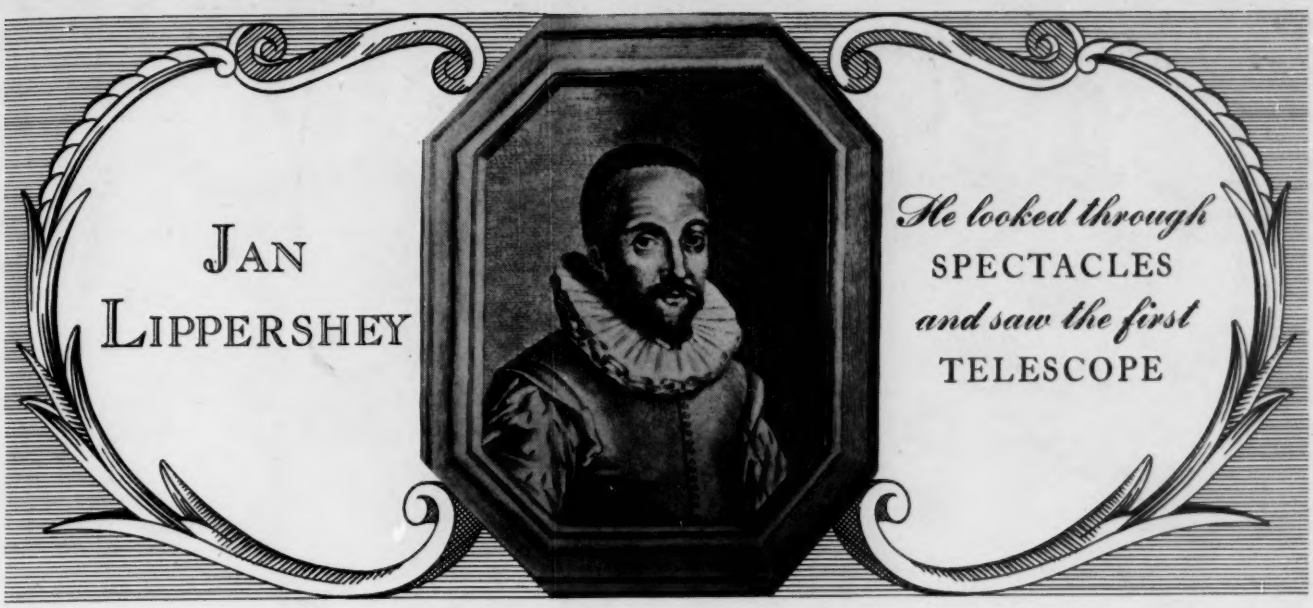
Orion. NGC 2244 (2[1]), $6^h\ 27^m$, +4° 56′; open cluster of 16 stars; diameter 40′.

L. S. COPELAND

CHART CORRECTION: NGC 6543, in Draco, should be at $17^h\ 58^m.6$, +66° 38′.

STARS FOR APRIL

as seen from latitudes 30° to 50° north, at 10 p.m. and 9 p.m. on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion. All co-ordinate lines are parts of circles.



PRESBYOPIC EYES had been looking through convex-lensed spectacles for 300 years when Jan Lippershey took his famous look. Only after glasses had been developed to correct near- and far-sightedness did fate place the right combination of convex and concave lenses in the hands of this Dutch spectacle maker.

In October of 1608, Lippershey applied for a 30 year patent on the first telescope. Although his petition was denied, he received 900 florins each for several binocular adaptations and a liberal retainer fee which gave the State exclusive rights to his services.

No picture of the first telescope exists, and recorded descriptions are vague. It probably was about 18" long, had a 1¼" aperture, magnified three or four diameters and had an extremely restricted field of view.

Crude though it was, it started human vision on a romantic journey. Today that journey continues through new lenses and prisms into new worlds of light and life and distance. Guiding it are busy men in industry, in education and in the armed forces . . . men with whom Perkin-Elmer has been privileged to create new milestones in optical science.

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Unusual optical parts worked from crystalline materials such as quartz, calcite, fluorite, lithium fluoride, sodium chloride, and potassium bromide.

PROBLEM: To inspect boiler tubes for defects without suspending operations.

SOLUTION: Perkin-Elmer designed and built for this power plant executive a boiler tube periscope that licked the problem.

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